POLLINATION SYNDROMES OF NEW WORLD *SALVIA* SPECIES WITH SPECIAL REFERENCE TO BIRD POLLINATION[1]

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ABSTRACT

The genus *Salvia* L. (Lamiaceae) encompasses about 1000 species, approximately two thirds of which are in the New World. Bees and birds are known as pollinators, but a more detailed analysis of the pollinator groups is lacking. This paper presents a complete list of all currently accepted New World *Salvia* species and their classification according to their pollination syndromes, focusing particularly on bird-pollinated species. The concept of pollination syndromes is used and complemented by field investigations, morphometric measurements, and experiments to reconstruct the process of pollen transfer and to confirm the fitting or exclusion of a given pollinator group. Within the 602 New World *Salvia* species, 58% are identified to be melittophilous (bee pollinated) and 31% to be ornithophilous (bird pollinated). *Salvia whitehousei* Alziar is assumed to be psychophilous (butterfly pollinated/long-tongued fly pollinated). About 11% of the species show characters of two or more syndromes and eight species are not assignable to any group. Bird-pollinated *Salvia* species occur from North America southward to Chile and Argentina. They usually grow as shrubs or perennial herbs (97%) and have red flowers (at least 49%) of an average size of 34 mm (7–130 mm). With respect to their floral diversity and phylogeny, parallel evolution is evident.

RESUMEN

El género *Salvia* L. (Lamiaceae) comprende unas 1000 especies, de las cuales aproximadamente dos tercios habitan en el Nuevo Mundo. Abejas y aves han sido descritas como polinizadores en este clado, sin embargo, hasta ahora no se han realizado estudios detallados acerca de los grupos de polinizadores involucrados. El presente trabajo entrega un registro completo de las especies de *Salvia* del Nuevo Mundo actualmente aceptadas y su clasificación de acuerdo a los síndromes de polinización, con énfasis en las especies polinizadas por aves. De las 602 especies de *Salvia* del Nuevo Mundo, 58% se identifican como melitófilas (polinizadas por abejas) y 31% como ornitófilas (polinizadas por aves). Sólo *S. whitehousei* Alziar es considerada como psycófila (polinizada por mariposas/moscas de larga probóscide). Cerca del 11% de las especies presenta caracteres de dos

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o más síndromes distintos y ocho especies no son asignables en ningún grupo. Especies de *Salvia* polinizadas por aves se encuentran desde Norteamérica hasta Chile y Argentina por el sur. Éstas adoptan generalmente una forma de vida arbustiva o de herbáceas perennes (97%) y evidencian flores rojas (al menos 49%) con un tamaño promedio de 34 mm (7–130 mm). Acorde a la filogenia, la diversidad floral observada evidencia evolución en paralelo dentro del género.

Key words: Floral morphology, Lamiaceae, melittophily, morphometry, New World *Salvia* species, ornithophily, parallel evolution, pollination syndrome, pollinator fitting and exclusion, psychophily.

Historically, the genus *Salvia* L. (sages, ca. 1000 species; Lamiaceae) has been associated with European bee-pollinated species, e.g., *S. pratensis* L. and *S. officinalis* L. With these species, Sprengel (1793) observed pollen transfer by the genus-specific staminal lever mechanism for the first time (see Claßen-Bockhoff et al., 2003). Today, this Europe- and bee-centered view is inadequate because two thirds of all *Salvia* species occur in the New World, many of them being bird pollinated (Alziar, 1988b, 1989a, 1989b, 1990, 1992, 1993; Wester & Claßen-Bockhoff, 2007).

Nevertheless, bees are the dominant pollinator group in the genus (e.g., Hildebrand, 1865; Grant & Grant, 1964; Kugler, 1972; Hedström, 1985; Dieringer et al., 1991; Claßen-Bockhoff et al., 2004b). Only rarely were other insects like butterflies, moths, or flies observed or assumed to be pollinators (Sprengel, 1793; Hildebrand, 1865; Müller in Möller, 1921; Faegri & van der Pijl, 1971; Read, 1983; Grases & Ramírez, 1998; Potgieter & Edwards, 2001; Fenster et al., 2004; Wester & Claßen-Bockhoff, 2006a, 2006b; Wester, unpublished). Except for four Old World species (Wester & Claßen-Bockhoff, 2006b), bird-pollinated flowers are restricted to the New World (Delpino, 1868–1874; Trelease, 1881; Cruden et al., 1983; Reisfield, 1987; Ramamoorthy & Elliott, 1998), where hummingbirds (Trochilidae) are by far the most important flower visitors (e.g., Salvin, 1860; Wagner, 1946; Grant & Grant, 1968; Wester & Claßen-Bockhoff, 2006a; but see Torke, 2000, for the Bananaquit *Coereba flaveola* L., a passerine bird).

Although bird-pollinated flowers in *Salvia* have been known for more than 150 years (Sclater, 1856), a comprehensive study is still lacking (but see Wester & Claßen-Bockhoff, 2007). Indeed, it is completely unknown how many species are ornithophilous and whether bird pollination evolved only once or several times in parallel.

The aim of this paper is to present a survey of the bird-pollinated sages of the New World, their number, distribution, and floral diversity. In view of the ca. 600 New World species, this is an ambitious project and some methodic compromises are necessary. We combine data from our field investigations with morphometric data from herbarium specimens and the literature and postulate that specialized bird-pollinated species should have floral traits to exclude bees from reaching the nectar.

Floral traits characterizing adaptation to a certain pollinator guild are summarized in the well-known pollination syndromes (Blumenstile: Vogel, 1954) or flower classes (van der Pijl, 1961). Although they have been criticized recently (Ollerton, 1996; Waser et al., 1996; Ollerton et al., 2009), specific combinations of floral traits are helpful tools to roughly assign flowers to pollinators (see also Consiglio & Bourne, 2001; Hargreaves et al., 2004; Martén-Rodríguez et al., 2009; Wester et al., 2009). They provide, however, only a first hypothesis to be verified by field observations. Because it is impossible to study all New World sages in the field, we introduce a new test to verify the pollination syndrome. Instead of only confirming the fitting between flower and pollinator we also test the opposite, i.e., the capacity to exclude non-pollinators.

Based on all data available, we preliminarily group the New World sages as being either adapted to only one pollinator group (bees, birds, butterflies/long-tongued flies) or adapted to more than one pollinator group due to intermediate floral traits. We list all New World *Salvia* species according to their actual taxonomic status, classify the species as to their pollination syndrome, and illustrate in particular the floral diversity in bird-pollinated species.

MATERIALS AND METHODS

SALVIA SPECIES

In the present study 602 *Salvia* species are included. The data derive from observations of wild and cultivated plants and are supplemented by data from herbarium specimens and the literature.

Living plants were examined for 116 species. During field studies in Bolivia (February–April 2002), Mexico and Guatemala (October–December 2003), and the United States (April–June 2004), 69 species were observed in their natural habitats.

Cultivated plants (83 species) were examined at the following places: (1) the Botanical Gardens Mainz (mainly wild collections; Germany), Hamburg (Germany), University of California Botanical Garden at Berkeley, Fullerton Arboretum, Rancho Santa Ana Botanic Garden, Univerity of California Riverside Botanical Gardens, The Huntington Botanical Gardens, Tilden Regional Park Botanic Garden (all California, U.S.A.), Chihuahuan Desert Gardens (El Paso, Texas, U.S.A.); (2) the nurseries E. Hügin (Freiburg, Germany) and Native by Native Landscapes (Johnson City, Texas, U.S.A.); and (3) the private gardens of F. Berndt (Cochabamba, Bolivia), B. Clebsch (Santa Cruz, California, U.S.A.), and M. Dimmitt (Tucson, Arizona, U.S.A.).

Fresh flowers were fixed in 70% ethanol for further investigations. Vouchers are deposited at MJG with some duplicates in B, BIGU, UC-JEPS, K, LPB, MEXU, TEX-LL, and UCR (Appendix 1). Herbarium specimens originated from AAU, ARIZ, B, BIGU, BM, C, CGE, COL, COLO, F, FLAS, G, GH, GOET, H, HAO, HUT, K, L, LD, LPB, MEXU, MICH, MJG, MO, NA, NY, OAX, P, RSA, S, SD, TEX-LL, UC-JEPS, UCR, US, W, WU, XAL, and ZEA (see Appendix 1). Specimens examined in the field or herbarium specimens were identified by means of the literature (see Appendix 1), type material, and with the aid of J. Wood (OXF), A. Vázquez (IBUG), A. Espejo (UAMIZ), H. Vibrans (CHAPA), M. Véliz (BIGU), C. Froissart (Olivet, France), and A. Sanders (UCR). Because there is no actual revision of *Salvia* subg. *Calosphace* (Benth.) Benth., we did not include species with an unclear taxonomic status (partly listed as nomen dubium by Epling, 1939, or not listed in the floras), undescribed species (e.g., species ined., or sp. A in Pool, 2007), and probable hybrids from cultivation (*S. ianthina* Otto & Dietr.).

POLLINATOR OBSERVATIONS

Observations of floral visitors including birds, bees, butterflies, hawkmoths, and flies were made in the field, botanical gardens (Berkeley, Rancho Santa Ana, Riverside, and Fullerton Arboretum), and a private garden (F. Berndt, Bolivia; see also Wester & Claßen-Bockhoff, 2006a, 2007). The birds were determined after Schuchmann (1999) and with the help of J. F. Ornelas and C. González (both from Instituto de Ecología, Xalapa, Mexico), M. Ordano (Universidad Nacional Autónoma de México, Mexico City, Mexico), O. Reyna (Universidad de Guadalajara, Mexico), and G. Stiles (Universidad Nacional de Colombia, Bogotá, Colombia).

POLLEN TRANSFER SIMULATION

To test the fit between flowers and pollinators and confirm the exclusion of certain visitors as pollinators, the process of pollen transfer was experimentally simulated. For this purpose, a museum skin or metal rod was inserted into the fresh flowers (see Wester & Claßen-Bockhoff, 2006a, 2006b). The functionality of the lever mechanism, the morphometric needs for a successful pollen transfer, and the site and precision of pollen deposition were recorded at the living material. The skins were borrowed from the Colección Boliviana de Fauna, La Paz, Bolivia (CBF), and the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK).

PLANT TRAITS

To identify the pollination syndrome, floral structures were morphologically and morphometrically investigated:

The length of the flower was measured from the proximal end of the flower to the distal end of the upper lip, the length of the flower tube from the proximal end of the flower to the flower entrance, and the upper lip from its distal end to the flower entrance.

Because the position of the lower lip is important for excluding bees, it was classified as reflexed (bent downward more than 90°), deflexed (bent downward about 90°), or antrorse (bent downward less than 90° to 0°). It was noted when the lips are oriented close to each other (lengthening the tube) and when the lateral lobes of the lower lip were vertically, rather than horizontally, oriented. The lower lip was called cup-shaped when its apical margins were incurved.

Flower shape was classified as bilabiate when the lips were dominant compared to the tube and tubular when the tube (with or without elongation by the lips) was more dominant. Flowers with a combination of both shape characters were classified as intermediate. Stielteller flowers (sensu Vogel, 1954) have long, slender tubes with lobes spreading at a right angle (salverform).

Structures for nectar retention at the base of the flower were classified as definite constrictions (emarginations, folds) of the corolla, definite (papillae) or weak (ridges) outgrowths of the corolla wall and hairs, and posterior lever arms (part of the staminal connectives reaching the proximal part of the flower).

Thecae exsertion indicates the distance between the distal end of the upper lip to the distal end of the thecae.

The corolla color of fresh flowers was determined after the CMYK color chart (C: cyan, M: magenta, Y: yellow, K [here S]: black; Küppers, 1999). Color data from the literature are often not well defined. We therefore classified color descriptions as follows: red includes all colorations from scarlet, claret, roseate to orange-red; pink includes rose and magenta; purple includes crimson; lavender includes light violet; blue includes royal blue; and dark violet includes almost black. If more than one color is mentioned, the species is defined in different ways or has color morphs. If known, the most frequent color was used. In a second step the colors were grouped: (a) yellow and orange; (b) red, orange, and yellow; (c) red; (d) red, purple, and pink; (e) purple, pink, and lavender; (f) blue and dark violet; and (g) white. Flowers that were not assignable to these classes because they include combinations with brownish ochre, red-brown, violet, or pale violet were grouped separately.

Floral nectar was measured as standing crop from cultivated plants (Botanischer Garten Mainz), usually in the morning of the first day of anthesis. Sugar concentration was determined using handheld refractometers (N1 [Atago, Tokyo, Japan]: 0%–32% sucrose percentage by weight [w/w]; N2 [Atago]: 28%–62% sucrose w/w; Eclipse 45–81 [Bellingham & Stanley, Kent, U.K.]: 0%–50% sucrose w/w). The volume of nectar was measured with a 25-μl microsyringe (ILS, Stützerbach, Germany).

Data on distribution, altitude, habitat, and growth forms were based mainly on the literature (see Appendix 1) and completed by our own observations. Because the growth form concept is only partly adequate for (sub-)tropical plants, we only roughly classified the species, mentioning more than one growth form when needed.

CLASSIFICATION

Pollinator groups were inferred from visitor observations; floral traits including size, shape, color, nectar, and scent; the fitting between flower and pollinator; and the capacity of the flower to exclude nonpollinator groups. We defined the exclusion of bees from the nectar by long and/or narrow corolla tubes, the exclusion of bees and butterflies by lacking landing platforms, and the exclusion of birds by very slender corolla tubes. Visitors are not pollinators if they do not touch the reproductive organs, e.g., if the stigma or pollen sacs are too far exserted to be touched by a bee. We are aware that during different seasons and at different localities the range of pollinators may vary, but nevertheless only animals that fit to the flower can act as pollinators.

RESULTS

Within the 602 examined New World sages, four groups can be distinguished. (1) Species with flowers that definitely exclude insects, but fit to birds. These are termed ornithophilous and are found in 184 species (30.6%). (2) Flowers that definitely allow bees access to nectar and morphologically fit to them. They form the largest group with 351 species (58.3%) and are grouped as melittophilous. (3) Species with flowers that exclude bees but enable butterflies or long-tongued flies to reach the nectar and touch the reproductive organs. This group only includes one species that is assumed to be psychophilous. (4) The remaining species (10.9%) do not fit to one of these groups. They are either so variable that they allow several pollinator guilds access to nectar or are not sufficiently known to be grouped (see Appendix 2).

ORNITHOPHILOUS SPECIES

In 17 species, hummingbirds were observed to pollinate the flowers, i.e., to touch pollen sacs and stigmas, while bees and butterflies were also attracted but did not pollinate. Based on these data, we identify them as ornithophilous.

They share the following (floral) traits (Table 1A, B):

Total flower length/corolla tube length. The total flower length ranges from 13 cm in *Salvia dombeyi* Epling (Fig. 1A) to 7 mm in *S. confertiflora* Pohl (Fig. 1D), and the length of the corolla tube ranges from 9 cm to 5 mm in these species, respectively (Figs. 2, 3). Regarding the geographic distribution, the longest flowers occur in the Andes (especially Peru, *S. dombeyi*), in Brazil (also where the shortest flowers occur), and in Mexico and Honduras.

Flower shape. The flower shape is bilabiate in 33 species (18%; Fig. 1B, L, M, O, Q, R), tubular in 108 species (59%; Fig. 1C–K, N), and intermediate in 42 species (23%; Fig. 1A, P). The shape of the tubular flowers is mostly straight (parallel sides, e.g., in *Salvia iodantha* Fernald or *S. nervata* M. Martens & Galeotti in Fig. 1C, I), elliptic in outline (Fig. 1G), or funnelform (e.g., in *S. macrophylla* Benth., *S. pauciserrata* Benth., or *S. oppositiflora* Ruiz & Pav. in Fig. 1E, F, N).

Stability of the corolla. The stability of the corolla ranges from being stiff as in, e.g., *Salvia confertiflora*, *S. karwinskii* Benth., or *S. madrensis* Seem. (Fig. 1D, G, K) to weak as in, e.g., *S. sagittata* Ruiz & Pav. or *S. macrophylla* (Fig. 1E).

Stability of the lower corolla lip. The stability of the lower corolla lip varies from stable, e.g., in *Salvia confertiflora* (Fig. 1D) to weak, e.g., in *S. patens* Cav. or *S. sagittata*.

Lower corolla lip length/position. The length of the lower corolla lip ranges from 41 mm in *Salvia patens* to 1 mm in *S. nervata* (Fig. 1I) and shows diverse positions, being mostly antrorse (e.g., *S. dombeyi*, *S. gravida* Epling, and *S. atrocyanea* Epling in Fig. 1A, L, M), but also deflexed (e.g., *S. oaxacana* Fernald in Fig. 1O) to reflexed (e.g., *S. lasiantha* Benth., *S. macrophylla*, *S. pauciserrata*, and *S. karwinskii* in Fig. 1B, E–G). The lower lips may be additionally cupped with incurved front margins (e.g., *S. confertiflora* and *S. leucantha* Cav. in Fig. 1D, H). The lateral lobes may be oriented vertically (e.g., *S. confertiflora*, *S. leucantha*, and *S. madrensis* in Fig. 1D, H, K). In flowers with weak, very short, reflexed, or deflexed lower lips, the landing of insects is impossible or difficult. The same applies for antrorse lower lips that lengthen the functional tubes (e.g., in *S. confertiflora* and *S. leucantha* in Fig. 1D, H). Antrorse lip positions bent downward either slightly to almost a right angle may offer a potential landing platform; however, bees are excluded by tube length. In species with short flowers, the tubular shape and increased tube length caused by the antrorse lower lips are more abundant than in long-tubed flowers.

Corolla color. The flowers in ornithophilous *Salvia* species are always conspicuous. The color of the corolla is most often red (49%), but also orange, yellow, purple, pink, lavender, violet, and blue, and rarely brownish ochre or red-brown (Fig. 4). A weak color change occurs in *S. graciliramulosa* Epling & Játiva and *S. spathacea* Greene. The calyx is mostly green or sometimes weakly colored in portions. Especially in species with white flowers, the calyx can be more strikingly colored, e.g., mostly purple in *S. leucantha* (Fig. 1H), purple or white/whitish in *S. tomentella* Pohl, or light violet to whitish in *S. divinorum* Epling & Játiva. Several other species have colored calyces and bracts, e.g., red in *S. confertiflora* (Fig. 1D) and *S. regla* Cav., yellow in *S. madrensis* (Fig. 1K), pink in *S. involucrata* Cav., sometimes purple in *S. gravida* and *S. lasiantha* (Fig. 1B), dark red to purple or almost black in *S. spathacea*, violet-black in *S. atrocyanea*, or blue-black or whitish to light green in *S. paramicola* Fern. Alonso. Regarding the geographic distribution, there are no noteworthy characteristics in flower color, except a high percentage of red-flowered taxa in Brazil, whereas blue and dark violet flowers occur mainly in *Salvia* species from the Andes, Mexico, and Central America.

Nectar guides. Nectar guides are usually lacking, but in at least nine species they occur on the lower lip near the entrance and in at least 15 species they are sometimes present. Nectar guides are mostly white and sometimes dark red-blackish; both colors occur in *Salvia exserta* Griseb. The whitish stamens may contrast to a colored corolla, as for example in *S. atrocyanea* (Fig. 1M). In *S. alborosea* Epling & Játiva, the whole lower lip is white.

Nectary length. The nectary length varies from 1 to 5 mm and some nectaries are very voluminous (Table 1A, B).

Nectar. In all species examined, a large to medium volume of nectar with a mostly low to medium sugar concentration was produced (Table 1A, B).

Nectar retention structures. Nectar retention structures at the base of the corolla are rather common in ornithophilous *Salvia* species. In almost all species they appear as slight lateral and horizontal narrowings of the corolla tube (not included in Table 1A, B). In addition, there can be strong lateral or abaxial constrictions (including emarginations or folds), lateral ridges, papillae or hairs, as well as posterior staminal lever arms.

Toothlike structures of staminal connectives. In *Salvia* species of subgenus *Calosphace*, the staminal connectives often form toothlike structures near the abaxial side of their joints. They are relatively large in *S. lasiantha*, *S. atrocyanea*, *S. exserta*, or *S. guaranitica* A. St.-Hil. ex Benth., but small in *S. dombeyi*, minute in *S. gravida*, or even absent as in *S. oppositiflora*. In all ornithophilous *Salvia* flowers, they do not occlude the flower entrance, because they are either arranged laterally (*S. atrocyanea* in Fig. 1M; *S. exserta*) or greatly distal (*S. lasiantha* in Fig. 1B).

Thecae position. The thecae position varies from being enclosed by the upper lip in 101 species (e.g., in *Salvia dombeyi* or *S. atrocyanea* in Fig. 1A, M) to being exserted as much as 43 mm (*S. speciosa* C. Presl ex Benth.) in 64 species (e.g., *S. lasiantha*, *S. iodantha*, *S. macrophylla*, or *S. pauciserrata* in Fig.

Table 1A. Characteristics of the New World ornithophilous *Salvia* species (n = 184).

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Upper lip length, mm	Lower lip length, mm	Lower lip position*	Flower shape*	Nectar retention*	Exposition of thecae, mm	Corolla color*	Corolla color (CMYK)*
acuminata Ruiz & Pav.	59–65	47–50	12–15			b/t		0	Re	
adenophora Fernald	22–29	16–23	5–8	5–8	a, cu, v, lc	t	–	0	Re	M90 Y80 S00
alborosea Epling & Játiva	24–25	17–18	7–8	4	ah, cu?	t (f)		8–16	Re, Pu?	
altimitrata Epling	23	11	12			b	Rl	[4–8]		
altissima Pohl	29–33	16–18	13–15		[a]	b/t	Cb	0	Re	
apparicii Brade & Barb. Per.	40–50	35–40	7	4		t (f) or t			Re	
arbuscula Fernald	21–23	15–17	6	[3–5]	a	t	P	[4–8]	Pu	
arduinervis Urb. & Ekman	21–28	16–21	5–7	3–5	[a and/or d?]	t		5–8	Pi, Lav	
articulata Epling	41–61	28–45	13–16	12	d, a	b/t		0	Pu	
atrocaulis Fernald	44–47	25–30	19–21	17–20	d, a	b		0	Bl-daVi	
atrocyanea Epling	25–48	15–31	10–18	8–17	a, d	b	–	0	Bl-daVi	C99 M80–90 S00–10
ayavacensis Kunth	37–39	27–28	7–10	8–15	a and/or d	t		6–7	Bl-daVi	
bahorucona Urb. & Ekman	19–26	16–21	3–5	2–3	[r, d]	t			Ye, Or, Re	
balaustina Pohl	46–55	33–40	13–22	[27]?	a	b/t		0	Re	
benthamiana Gardner	36–48	20–30	16–18	[12–14]	a	b/t		0	Re	
betulifolia Epling	35–56	23–37	12–19	10–19	a	b/t		0	Re	
blepharophylla Brandegee ex Epling	28–36	18–25	8–11	10–19	mostly d, also r, a	b	Cb	0	Re	M99 Y99 S10
booleana B. L. Turner	30–42	18–27	12–15	10–12	[d]	b		0?	Re	
buchananii Hedge	39–50	24–30	15–20	15–20	a, d	b	Cb	0	Pu	C40 M99 Y10
cacaliifolia Benth.	22–28	17–20	4–10	8–10	ah, v, often cu	t (f)	PL	6–10	Bl(rb)	C95 M75 Y00
camarifolia Benth.	15–24	12–19	3–6	3–6	a, cu, v, lc	b/t		0	Re	
chapadensis E. P. Santos & Harley	42–46	30–33	12–15	8–10		b/t		0	Re	
cinnabarina M. Martens & Galeotti	20–33	15–25	5–8	4–6	a	t	PL	4–9	Re	M99 Y70 S10
clarkcowanii B. L. Turner	26–37	21–28	6–10	4–9	a	t	Cb	3–9	daVi	
coccinea Buc'hoz ex Etl.	20–30	13–22	4–8	10–13	d	t	–	3–9	Re	M99 Y99 S00–20
cocuyana Fern. Alonso	12–15	11–14	1	2–3	a, v	t	PL?	0	Re	
confertiflora Pohl	7–13	5–9	2	2–3	ah, cu, v, lc	t	–	0	Re	M90 Y99 S10
cubensis Britton & P. Wilson	18–25	13–19	5–6		[a]	t			Re	
curtiflora Epling	19–31	17–27	2–4	2–4	ah, v	t	PL	1–3	Re, Pu	C30 M99 S20
curviflora Benth.	28–35	18–22	10–13	8	a	b/t	P	0	Pu	

Table 1A. Continued.

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Upper lip length, mm	Lower lip length, mm	Lower lip position*	Flower shape*	Nectar retention*	Exposition of thecae, mm	Corolla color*	Corolla color (CMYK)*
cyanocephala Epling	28–45	20–36	4–12	5–15	r, possibly d, [a]	t	PL	1–6	Bl-daVi	
cylindriflora Epling	49	43	6	[6]		t		[4]		
darcyi J. Compton	36–44	24–27	12–17	15–20	d, also weakly r	b	P, Cb	0	Re	M90 Y90 S00
diamantina E. P. Santos & Harley	45	28–30	14–15	7–8		b/t		0	Re	
disjuncta Fernald	(18)26–46	(14)20–39	(4)6–13	(4)6–13	a, d, sometimes lc	t	Rl	0	Re	M90–99 Y90–99 S00–10
divinorum Epling & Játiva	28–35	19–27	6–10	5–7	a, cu, v, lc	t		0	Wh (calyx paVi to whitish)	C00 M00 S00 (calyx whitish with C40–45 M45–50 S00)
dombeyi Epling	(85)98–130	(60)80–90	22–30	19–24	a	b/t		0	Re	M99 Y99 S10
dorisiana Standl.	53–64	35–40	19–24	15–23	d, also r	b/t	P, Cb	0	Pi	C20–30 M90 S00–10
dugesiana Epling	31–38	23–28	8–9	[8–9]	[a]	b/t		0	Re	
elegans Vahl	28–39	18–29	8–13	7–12	a, sometimes d	t	–	0–4	Re	M99 Y80 S20
ernesti-vargasii C. Nelson	24–30	20–24	4–6	3–4	d, bc	t	P?	0	Re	
erythrostephana Epling	22–23	17–20	[4–5]	[5–6]	a	t		0	Pi	
espirito-santensis Brade & Barb. Per.	55–60	40–45	18–20	15–16	a	b/t		0	Re	
exserta Griseb.	14–36	10–28	4–9	7–15	r, d	t	H	6–22	Re	M99 Y99 S10
falcata J. R. I. Wood & Harley	26–35	16–33	10–12	5–7	[a]	b/t		0	Re	
florida Benth.	30–42	24–35	5–7	5–8	d	t	PL	8–12	Pi, Pu	M99 Y20 C70
formosa L'Hér.	38–47	23–28	15–18	13–15	d, a	b	P	0	Re	
foveolata Urb. & Ekman	18–28	14–22	4–6	3–5	[d]	t		7–11	Ye	
fruticetorum Benth.	38	32	6			t		[1]?	Re or Pu?	
fulgens Cav.	38–61	25–39	13–24	16–23	a, also d, sometimes r	b	P, weak Cb	0	Re	M99 Y70 S10
funckii Briq.	25–31	18–21	9–11	13–16		t (f)	PL	[13–18]	Bl	
gachantivana Fern. Alonso	12–20	11–19	1	1–3	a and/or d, v	t	PL?	0	Re	
gesneriiflora Lindl. & Paxton	50–66	28–44	15–23	15–24	a, d	b	–	0	Re	M99 Y80 S10, M95–99 Y99 S00

Table 1A. Continued.

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Upper lip length, mm	Lower lip length, mm	Lower lip position*	Flower shape*	Nectar retention*	Exposition of thecae, mm	Corolla color*	Corolla color (CMYK)*
graciliramulosa Epling & Játiva	25–46	18–28	11–18	14–23	a, d	b	P, Cb	0	Re	young/adult: M90–99 Y50–90 S30, M99 Y60 S40, M99 Y50 S20 to old: M90–70 Y00 S30
grandis Epling	22–23	16–17	6	6	[a]	t	P	0	Pi, Pu	
gravida Epling	44–58	27–36	17–22	20–22	a, also d	b	–	0	Re, Pu	C50 M99 S00, C10 M99 S60, C60 M 99 Y60
greggii A. Gray	26–32	18–22	8–11	[13–14]	d, also a, r	b	–	0	Re, Pu	C00 M00 S00 (white cultivar)
grewiifolia S. Moore	18–34	14–20	9–14	9–12	a, v, lc, sometimes cu	t	Cb	0	Re	M99 Y99 S00
guaranitica A. St.-Hil. ex Benth.	30–56	20–37	11–19	10–17	a	b	–	0	Bl-daVi	C99 M85–90 S00
haenkei Benth.	18–50	15–40	5–10	5–8	r	t	–	5–10	Re	M90–99 Y80–99 S10, M90 Y70 S00, M60 Y90 S00
hapalophylla Epling	32–35	26–28	6–7	[4–5]	[d]	t		[5–9]	Re	
harleyana E. P. Santos	8–9	6–8	2	2	[a, v]	t		0	Re	
hatschbachii E. P. Santos	60–64	43–45	17–19	14–17	[a?]	t		0	Re	
heerii Regel	31–32	25–26	6	ca. 6	r	t (f)	PL	[13–20]	Re	
henryi A. Gray	28–39	22–31	6–8	8–9	d, also a	t	–	0–6	Re, rarely Pi, Pu	M 90 Y20 S00 (cult.)
herrerae Epling	16–22	11–17	3–6	2–5	[a, v]	b/t		0	Re	
hidalgensis Miranda	23–58	18–41	5–18	4–14	[r and/or a]	b/t	H?	0	Ye	
hilarii Benth.	40–47	30–34	10–13	[11]		b/t		0	Re	
hirta Kunth	29–32	25	4–6	[4–6]	a	t	PL	[7–13]	Re	
hirtella Vahl	24–33	20–29	4–6	6–10	d, also r	t	P	7–17	Re	M90 Y90 S10
holwayi S. F. Blake	24–31	15–24	5–8	5–6	r/bc, also d, [a]	t	P, Cb	0	Re, Pi	M99 Y80 S00
integrifolia Ruiz & Pav.	35–46	30–40	5–6	[4–6]		t	PL	[4–10]	Or, Re	

Table 1A. Continued.

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Upper lip length, mm	Lower lip length, mm	Lower lip position*	Flower shape*	Nectar retention*	Exposition of thecae, mm	Corolla color*	Corolla color (CMYK)*
involucrata Cav.	33–43	21–35	7–9	7–10	r + d/bc, sometimes a	t	P, Cb	0	Pi	C20 M99 S00
iodantha Fernald	20–27	15–20	5–7	4–5	a, d, r	t	P	5–7	Pu	C40 M90 S00
iodophylla Epling	34–35	27–28	7	[7–8]	[a, r]	t	P	4–6	Re	
itaguassuensis Brade & Barb. Per.	29	23	4	3		t			Re	
iuliana Epling	48	30	18	ca. 13		b		0		
jorgehintoniana Ramamoorthy ex B. L. Turner	40–55	32–45	7–10	5–6	r, d, a	t	PL	5–10	Re	
karwinskii Benth.	26–36	18–27	6–10	3–7	r/bc	t	P, weak Cb	0	Re, Pi	M90–99 Y40–50 S10
lachnaioclada Briq.	17–27	13–22	4–5	3–4	[d]	t		[4–7]	Ye, Or, Re	
lachnostoma Epling	38–43	28–32	10–11	[9]		t		0	Re, Pu	
lanicaulis Epling & Játiva	23–25	18–20	5	[5–8]		t (f)		[7–11]	Re	
lasiantha Benth.	(11)15–26	(6)8–12	(5)6–16	3–12	r, d, sometimes a	b	Rl	3–8	BrOc, Ye, Or, Re, ReBr, Pi, Pu, Vi	M60–80 Y70–99 S10, M80 Y99 S50, M90 Y70 S60, M99 Y70 S40, M99 Y50 S70, M60 Y30 S60, M90 Y40 S50, M80 Y30 S60
lavendula Alain	13–17	10–14	3	3–4		t		[5]	Lav	
leucantha Cav.	16–20	13–17	3–6	3–5	ah, cu, v, lc	t	–	0	Wh (calyx Pu, rarely Wh)	C00 M00 S00 (calyx C70–90 M90–99 Y00–20)
leucocephala Kunth	32–44	20–28	12–19	[9–12]	r	b/t	–	0	Pu	C70 M99 Y50
libanensis Rusby	53–63	33–43	20–23	17–22	a	b/t		0	Re	
lineata Benth.	26–45	20–28	6–12	8–13	a	b	P, Cb	0	Re	M90 Y90 S00
littae Vis.	24–36	15–23	9–14	6–11	r	b	P	0	Pi, Pu	C30–50 M99 Y00–20
lobbii Epling	27–36	21–28	5–8	5–8	d	t (f)	PL	[7–12]	Bl-daVi	

Table 1A. Continued.

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Upper lip length, mm	Lower lip length, mm	Lower lip position*	Flower shape*	Nectar retention*	Exposition of thecae, mm	Corolla color*	Corolla color (CMYK)*
longibracteolata E. P. Santos	14	11	3	3	ah, cu, v, lc			0	Re	
longistyla Benth.	33–45	27–37	6–8	4–9	d, a	t	PL	6–9	Re	M99 Y50–70 S40
macrocalyx Gardner	45–49	30–33	15–16	8–10		b/t		0	Re	
macrophylla Benth.	20–26	11–18	6–13	7–11	r	t (f)	PL	10–15	Bl(rb)	C99 M70 S00
madrensis Seem.	23–35	18–26	4–9	3–9	a, v, lc	t	–	0	Ye	Y80 M10 S10
marci Epling	22–38	14–23	10–18	6–16	[d]	b		0	Pu	
mattogrossensis Pilg.	25–35	20–22	5–6	[3–4]	ah, cu, v, lc	t		0	Re	
medusa Epling & Játiva	28–56	21–46	7–12	6–13		t (f)	PL	8–10	Bl-daVi, sometimes Pu	
melaleuca Epling	35–45	32–38	6–15	12–20	[d, r?]	b/t	PL	4–7	Re	
melissiflora Benth.	14–18	11–16	3–4	[2–3]	[a, also ah]	t		[0–1]?	Re	
mentiens Pohl	28–41	22–34	5–8	5–7	[a]	t		0	Pi, Pu	
microphylla Kunth	20–32	14–20	6–12	7–15	d, also a	b	PL	0	Re, Pu, Pi	C50 M99 Y00, C20–30 M90–99 Y00–40, C10 M99 Y50
miniata Fernald	28–42	20–27	8–15	12–14	d, also cu	b	–	0	Re	M99 Y90 S10, M99 Y90 C20
neovidensis Benth.	29–31	25–26	4–5			t		5–7		
nervata M. Martens & Galeotti	30–44	21–29	8–15	1–3	ah, v	t	PL	0–1	Re, Pu	M99 Y30 S60
nigrescens Alain (nom. illeg.)	25–30	[16–19]	[9–10]			t		[1–3]?	Re	
oaxacana Fernald	32–42	15–21	7–22	12–15	d, r, rarely a	b	Cb	0	Re	M99 Y60–70 S10–20
ombrophila Dusén	22–28	16–21	5–7	5–9	r, d, [a]	b/t		0	Re, Pi?	
oppositiflora Ruiz & Pav.	21–42	16–34	5–11	5–12	a, also ah, v, lc, sometimes cu	t (f)	PL	2–6	Re, Pi	M90 Y90–99 S00
orbignaei Benth.	32–51	18–29	10–23	9–21	d	b	P, Cb	0	Pi, Pu, rarely Wh	C00–30 M80–99 S00, also C00 M60–80 S00, C00 M5–10 S00
orthostachys Epling	12–15	11–14	1	2	d, [a, v]	t	PL?	0	Re	
oxyphora Briq.	30–48	22–38	5–11	7–12	d, a, also bc	t	P, Cl	0	Re, Pi	M90 Y60 S00, M90–99 Y00–30 S00–10

Table 1A. Continued.

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Upper lip length, mm	Lower lip length, mm	Lower lip position*	Flower shape*	Nectar retention*	Exposition of thecae, mm	Corolla color*	Corolla color (CMYK)*
palealis Epling	25–26	17–19	5–6	5–6	[a]	t	P	3–6	Re	
paramicola Fern. Alonso	24–26	18–19	5	[5–6]	[a, cu, lc, d]	t		0	daVi(Black)	
paryskii Skean & Judd	25–31	20–25	5–6	4–5	d	t			Ye, Or	
patens Cav.	40–63	15–28	23–35	27–41	d	b	Cb	0	Bl(rb)	C99 M75 S10
pauciserrata Benth.	25–59	15–46	7–18	9–15	r, d [a]	t (f)	PL, P	7–12	Re	M99 Y99 S10
pavonii Benth.	16–22	12–18	5–6	4–6	[a]	t		0	Ye	
peninsularis Brandegee	21–29	15–23	6–8	6–9	d	b/t		0	Pi, Pu, Lav	
pentstemonoides Kunth & C. D. Bouché	27–40	15–27	11–16	9–11	d, a, also cu, v	b	H	0	Re, Pu, Pi	C40 M99 S60
persicifolia A. St.-Hil.	45–50	30–35	15	8–9		b/t		0	Re	
phaenostemma Donn. Sm.	23–25	17–18	6–7	ca. 6		t		7–8	Bl or daVi	
pichinchensis Benth.	31–43	20–26	11–18	[12–18]	[d]	t	PL	[9–15 and more]	Bl, daVi	
plumosa Ruiz & Pav.	47	35	12	15		b/t	P	0		
pringlei B. L. Rob. & Greenm.	32–44	22–24	15–20	8–10	a, also d	b		0	Pu	
psilantha Epling	34–43	26–33	8–11	[8–9]		t		5–11		
pubescens Benth.	39–68	25–45	14–23	15–23	a	b/t		0	Re	M90 Y99 S10
pulchella DC.	24–30	16–21	7–9	7–11	a, [d?]	b	P, Cb	0	Re	
quitensis Benth.	33–39	27–32	6–8	[5–10]		t	PL	[8–12]	Re	
raveniana Ramamoorthy	32–34	19–22	12	[7–10]	[r]	b	P	0–3	Re, Pu, Pi	
regla Cav.	27–59	19–41	8–22	8–24	a, d	b/t	–	0	Re	M90 Y80 S00
regnelliana Briq.	40–44	27–30	13–14	[10–14]	a	t		[3]?	Re, Pu	
rhodostephana Epling	22–34	15–25	7–9	14–18	d	t (f)	PL	[7–16]	Pi, Pu, paVi, Bl	
rivularis Gardner ex H. B. Fielding	42–53	30–40	12–13	6–15	a	b/t		0	Re	
roemeriana Scheele	24–47	18–39	6–9	6–15	d, sometimes a, r	t	H	0–7	Re	M90–99 Y60–80 S20
rosei Fernald	25–31	18–20	9–11	[8]		b		2–3	Pi, Pu	
rubescens Kunth	20–39	18–31	2–6	8–10	a, also d	t	PL	0–4	Re	M99 Y90 S10
rubrifaux Epling	32–38	24–30	8–11	[8–11]	[a]	b/t		10–13	Re	
rubriflora Epling	25–30	20–22	8–9	8–17	d	t (f)	PL	15–18	Re	
rufula Kunth	16–40	11–25	5–13	4–9	a, [d, r]	b		0	Re	
rusbyi Britton ex Rusby	40–58	29–46	8–14	8–15	d, a	b/t	–	0–11	Re	M90–99 Y99 S00–10

Table 1A. Continued.

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Upper lip length, mm	Lower lip length, mm	Lower lip position*	Flower shape*	Nectar retention*	Exposition of thecae, mm	Corolla color*	Corolla color (CMYK)*
sagittata Ruiz & Pav.	23–31	16–21	5–10	12–18	d	t (f)	PL	8–13	Bl(rb)	C99 M80 Y00
salicifolia Pohl	47–56	32–36	15–20	10–12	[a]	b/t		0	Re	
scabrata Britton & P. Wilson	32–35	20–22	10–14	8–10	a	t		0	Re	
scabrida Pohl	35–48	25–30	10–18	5–8	[a]	b/t		0	Re	
scandens Epling	50–63	38–45	12–18	16	a	b/t	P	0	daVi	
sciaphila (J. R. I. Wood & Harley) Fern. Alonso	35–43				a	b/t	P	0	Pu	
secunda Benth.	9–13	7–10	2–3	2–3	ah, lc, v, cu	t		0	Re	
sellowiana Benth.	42–62	30–45	12–17	11–15	d, a	b/t		0	Re	
sessei Benth.	30–62	20–42	10–22	9–22	a	b/t	–	0	Re	M99 Y90 S10
sigchosica Fern. Alonso	18–24	11–14	7–10	[ca. 10]	[d, r?]	t	[PL?]	9–10	daVi	
spathacea Greene	28–46	22–37	5–10	6–14	d, r	t	sometimes Cb	7–17	Re, Pu, Pi, rarely Ye	M80 Y40 S30–40 (young), M99 Y30(–00) S50 or C20 M99 S10 to C50 M99 S00 (adult)
speciosa C. Presl ex Benth.	20–23	15–19	5–8	10–14	a or d	b/t		[22–43]	Pu, daVi	
speirematoides C. Wright	24–27	18–22	5–6	[3–4]		t		4–6	Re	
splendens Sellow ex Roem. & Schult.	38–49	30–40	8–11	3–6	ah, cu, lc	t	–	0–1	Re	M90–99 Y90–99 S00
sprucei Briq.	30	24	6	[9–10]	d	t	PL	[8–10]	Pi	
squalens Kunth	32–44	22–29	10–17	16–19	d, a	t (f)	PL	2–6	Re, Pi	M99 Y99 S10, M80 Y70 S00
stolonifera Benth.	(34)39–50	(22)30–35	11–16	9–17	a	b	P, Cb	0	Or, Re	
striata Benth.	27–45	19–32	6–13	5–11	ah, cu, v, lc	t (f)	PL	0–5	Re, Pi	M30 Y00–20 S00, M50 Y10 S00, M90 Y90 S00
subhastata Epling	39–43	27–35	11–13	[11–12]	a	b/t		0	Wh, Pi, Ye	
subrotunda A. St.-Hil. ex Benth.	17–29	12–22	4–7	6	d, a	t		3–4	Re	
subrubens Epling	33–34	24	9–10	[10]		t		2–3		
summa A. Nelson	26–48	19–39	7–11	13–17	d, rarely a	t	H	0–2	Pi, Pu	C20 M70 S00
tenuiflora Epling	32–48	22–38	10	[6]	a	t		4–6	Re	

Table 1A. Continued.

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Upper lip length, mm	Lower lip length, mm	Lower lip position*	Flower shape*	Nectar retention*	Exposition of thecae, mm	Corolla color*	Corolla color (CMYK)*
thormannii Urb.	28–33	22–27	6	6		t		6–11	Or, Re	
tolimensis Kunth	22–27	15–16	9–11	[5–7]	[r, d, a]	b	P	0	Pu	
tomentella Pohl	22–23	17–18	5	3–6	ah, cu, v, lc	t		0	Wh (calyx Pu, whitish gray?)	
tortuosa Kunth	(18)28–45	(12)15–26	(6)9–18	(4)8–11	d, r	b	–	0	Pu	
townsendii Fernald	27–34	21–26	6–8	[5]	[a]	t	P	5–9	Pu	
trachyphylla Epling	32–33	25	7–8	10	a	t		[10–11]	Re, Pi	
tubifera Cav.	26–31	22–25	5–7	2–6	r	t	PL	0	Re	M99 Y60 S30
tubiflora Sm.	40–44	30–35	10–11	[6–8]	ah, cu, v, lc	t (f)	PL	[0–7]	Re	
tubulosa Epling	40–47	30–35	10–12	[9–12]		b/t		0	Re	
tuerckheimii Urb.	27–34	24–30	5–7	3–7	[r and/or d]	t		6–10	Or, Re	
uncinata Urb.	20–29	16–26	4–6	3–5	[r or d]	t		[7]	Ye, Or, Re	
unguella Epling	10	9	1	2	[a]	t		0	Re, Pi	
univerticillata Ramamoorthy ex Klitg.	25–36	18–26	7–10	8–10	r/bc	t	P	0	Re	M99 Y60 S30
venulosa Epling	24	18	6	7	[ah, d]	t		0	Re	
verapazana B. L. Turner	20–26	15–20	5–7	5–7	[a]	t		0	Re	
vestita Benth.	65–67	50–52	11–15	14	[a]	b/t		[1–6]		
wagneriana Pol.	18–44	13–34	3–10	2–8	r/bc, also d	t	P, Cb	0	Re, Pu, Pi	M70–90 Y20–40 S00–10
weberbaueri Epling	47–48	35	12–13			b/t		0		
xanthotricha Harley ex E. P. Santos	15–16	13–14	2	1–2	ah, v, lc	t		0	Re	
xeropapillosa Fern. Alonso	13–14	11–13	1	2–4	a, also d, v	t	PL?	0	Re	
Mean and SD	34 ± 12.7	24.7 ± 9.1	9.6 ± 5	9.1 ± 5				3.1 ± 4.7		
Minimum and maximum	7–130	5–90	1–35	1–41				0–43		
n	184	183	183	174				176		

* Refers to the following classification (see Methods): **Lower lip position:** r = reflexed, d = deflexed, a = antrorse (ah = ± horizontal, not flexed), cu = cup-shaped, v = lateral lobes vertical, lc = lower and upper lips close to each other, bc = basal part of lower and upper lips close to each other. **Flower shape:** b = bilabiate, t = tubular (f = tube funnelform), b/t = intermediate. **Nectar retention:** P = papillae, Cl = lateral constriction, Cb = abaxial constriction (sometimes additionally adaxial), Rl = lateral ridges, H = hairs, PL = posterior lever arm, – = none of these characteristics. **Color:** Bl = blue, Bl(rb) = royal blue; BrOc = brownish ochre, Lav = lavender, Or = orange, Pi = pink, Pu = purple, Re = red, ReBr = red-brown, Vi = violet, daVi = dark violet, paVi = pale violet, Wh = white, Ye = yellow. CMYK after Küppers (1999; C: cyan, M: magenta, Y: yellow, K [here S]: black). Square brackets = preliminary data. Blank cells signify no data were available.

Table 1B. Characteristics of the New World ornithophilous *Salvia* species (n = 184).

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
acuminata Ruiz & Pav.					[13–17]	sh (sometimes sc)	PE	subg. *Calosphace*, sect. *Longiflorae*
adenophora Fernald	absent	26.2 ± 2.45 (21.2–30.1), n = 26	1	3	4–8	sh	MX	subg. *Calosphace*, sect. *Holwaya*
alborosea Epling & Játiva	whole lower lip white				[7–16]	ph	PE, EC	subg. *Calosphace*, sect. *Lopeziana*
altimitrata Epling						sh	MX	subg. *Calosphace*, sect. *Mitratae*
altissima Pohl					3–4	ph	BR	subg. *Calosphace*, sect. *Hoehneana*
apparicii Brade & Barb. Per.						ss	BR	subg. *Calosphace*, sect. *Curtiflorae*
arbuscula Fernald					[2–3]	ss	MX	subg. *Calosphace*, sect. *Iodanthae*
arduinervis Urb. & Ekman				2	2–5	sh	HT	subg. *Calosphace*, sect. *Ekmania*
articulata Epling					4–8	sh	BR	subg. *Calosphace*, sect. *Nobiles*
atrocaulis Fernald					5–12	ph	MX	subg. *Calosphace*, sect. *Dusenostachys*
atrocyanea Epling	absent	27.7 ± 3.1 (21.5–32.7), n = 18	1	2–3	3–4	ph	BO, AR	subg. *Calosphace*, sect. *Coeruleae*
ayavacensis Kunth					5–13	ph	PE	subg. *Calosphace*, sect. *Cylindriflorae*
bahorucona Urb. & Ekman				2–3	2–5	sh	HT, DO	subg. *Calosphace*, sect. *Ekmania*
balaustina Pohl					6–12	sh	BR	subg. *Calosphace*, sect. *Nobiles*
benthamiana Gardner					4–5	sh	BR	subg. *Calosphace*, sect. *Nobiles*
betulifolia Epling					2–5	sh	MX	subg. *Calosphace*, sect. *Erythrostachys*
blepharophylla Brandegee ex Epling	absent			3–4	5–10	ph	MX	subg. *Calosphace*, sect. *Brandegeia*
booleana B. L. Turner						ph	MX	subg. *Calosphace*, sect. *Fulgentes*
buchananii Hedge	pale pinkish white stripes	28.2 ± 3.4 (23–41.8), n = 27	10.8 ± 4.7 (4–15.5), n = 6; 1	2–3	2–4	ph	probably MX	subg. *Calosphace*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
cacaliifolia Benth.	absent	22.8 ± 3.4 (16.3–30.0), n = 45	7.8 ± 2.9 (2–15.5), n = 32; m	2–3	4–6	ph	MX, GT, HN	subg. *Calosphace*, sect. *Standleyana*
camarifolia Benth.					2–5	ss, sh	CO	subg. *Calosphace*, sect. *Tubiflorae*
chapadensis E. P. Santos & Harley					4–5	ss, sh	BR	subg. *Calosphace*, sect. *Nobiles*
cinnabarina M. Martens & Galeotti	absent			2	2–4	ph	MX, GT, SV, HN	subg. *Calosphace*, sect. *Incarnatae*
clarkcowanii B. L. Turner					3–5	sh	MX	subg. *Calosphace*, sect. *Purpureae*
coccinea Buc'hoz ex Etl.	mostly absent, also small white spots	25.7 ± 1.9 (22–27.8), n = 19	m	2	2–5	ah, ph	? (probably MX/Central America or BR)	subg. *Calosphace*, sect. *Subrotundae*
cocuyana Fern. Alonso					4–5	ph	CO	subg. *Calosphace*, sect. *Rubescentes*
confertiflora Pohl	absent	43 ± 12.3 (23–62), n = 61	m; ca. 3.5	2	2–6	ss	BR	subg. *Calosphace*, sect. *Secundae*
cubensis Britton & P. Wilson						sh	CU	subg. *Calosphace*, sect. *Brittonia*
curtiflora Epling	absent			3	3–4	sh	GT	subg. *Calosphace*, sect. *Curtiflorae*
curviflora Benth.						ph	MX	subg. *Calosphace*, sect. *Purpureae*
cyanocephala Epling	absent or white stripes				9–12	ss, sh	CO	subg. *Calosphace*, sect. *Siphonanthae*
cylindriflora Epling					8–16	sh	PE	subg. *Calosphace*, sect. *Cylindriflorae*
darcyi J. Compton	absent			3	4–12	ph	MX	subg. *Calosphace*, sect. *Holwaya*
diamantina E. P. Santos & Harley					5–8	ph, ss, sh	BR	subg. *Calosphace*, sect. *Nobiles*
disjuncta Fernald	absent	26 ± 4.1 (20.2–32), n = 12	1	2–4	3–9	ss (sc), sh	MX, GT	subg. *Calosphace*, sect. *Holwaya*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
divinorum Epling & Játiva	absent			3–5	4–9	ph	MX	subg. *Calosphace*, sect. *Dusenostachys*
dombeyi Epling	absent		l	3–5	10–34	ss (sc), sh, tr	PE, BO	subg. *Calosphace*, sect. *Longiflorae*
dorisiana Standl.	absent or white/ whitish area		l	4	6–14	ph	HN	subg. *Calosphace*, sect. *Holwaya*
dugesiana Epling					8–10	ss	MX	subg. *Calosphace*, sect. *Secundae*
elegans Vahl	absent	17.6 ± 4.3 (7.5–24), n = 18	m	2–4	2–3	ph, ss	MX	subg. *Calosphace*, sect. *Incarnatae*
ernesti-vargasii C. Nelson					6–10	sh	HN	subg. *Calosphace*
erythrostephana Epling					[5]	ss	GT, SV	subg. *Calosphace*, sect. *Tubiflorae*
espirito-santensis Brade & Barb. Per.						sh	BR	subg. *Calosphace*, sect. *Nobiles*
exserta Griseb.	absent or white/ blackish stripes	25.4 ± 5.9 (12–45), n = 117	l	1–2	2–6	ah	BO, AR	subg. *Calosphace*, sect. *Mineatae*
falcata J. R. I. Wood & Harley					1–2	ss	CO	subg. *Calosphace*, sect. *Tubiflorae*
florida Benth.	absent		l	3–4	6–10	sh (sometimes sc)	PE	subg. *Calosphace*, sect. *Floridae*
formosa L'Hér.					[6–7]	ss	PE	subg. *Calosphace*, sect. *Leonuroideae*
foveolata Urb. & Ekman				2–3	1–4	sh	HT, DO	subg. *Calosphace*, sect. *Ekmania*
fruticetorum Benth.						sh	BR	subg. *Calosphace*, sect. *Curtiflorae*
fulgens Cav.	absent	24.4 ± 2.2 (20–27), n = 15	12.7 ± 3.1 (9–16.5), n = 7; l	3	2–7	ph, ss, sh	MX	subg. *Calosphace*, sect. *Fulgentes*
funckii Briq.					4–7	ss (sometimes sc)	CO, VE	subg. *Calosphace*, sect. *Hastatae*
gachantivana Fern. Alonso				2	2–6	ph, ss	CO	subg. *Calosphace*, sect. *Rubescentes*
gesneriiflora Lindl. & Paxton	absent	26.7 ± 1.9 (22.5–31.2), n = 44	21.1 ± 10.7 (5.5–42.5), n = 17; l	2	5–13	sh	MX	subg. *Calosphace*, sect. *Holwaya*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
graciliramulosa Epling & Játiva	absent or lighter area	31.5 ± 4 (24.6–44), n = 25	1	2–3	5–7	ss	BO	subg. *Calosphace*, sect. *Exiles*
grandis Epling						sh	GT	subg. *Calosphace*, sect. *Steyermarkia*
gravida Epling	absent or white/ light area	23.4 ± 4.4 (11.5–30.5), n = 77	27.1 ± 10.2 (16–50), n = 13; 1	2–4	6–15	ph	MX	subg. *Calosphace*, sect. *Skeptostachys*
greggii A. Gray	absent or white			2–3	[5]	ph, ss	MX, US	subg. *Calosphace*, sect. *Flocculosae*
grewiifolia S. Moore	absent	29.4 ± 6.6 (19–53.5), n = 53	1	3–4	4–7	ss	BR, BO	subg. *Calosphace*, sect. *Hoehneana*
guaranitica A. St.-Hil. ex Benth.	absent			3–4	5–8	ph, ss	BR, PY, UY, AR	subg. *Calosphace*, sect. *Coeruleae*
haenkei Benth.	absent or sometimes white stripes	27.2 ± 2.2 (14–32), n = 144	26.5 ± 12.2 (12–50), n = 16; 1	2–3	6–11	ss	PE, BO	subg. *Calosphace*, sect. *Cylindriflorae*
hapalophylla Epling					2–3	ss	PE	subg. *Calosphace*, sect. *Cylindriflorae*
harleyana E. P. Santos						ss	BR	subg. *Calosphace*, sect. *Secundae*
hatschbachii E. P. Santos						ss	BR	subg. *Calosphace*, sect. *Nobiles*
heerii Regel	white/whitish stripes				[6]	ph	PE	subg. *Calosphace*, sect. *Cylindriflorae*
henryi A. Gray	absent			1	3–4	ph	US, MX	sect. *Heterosphace*
herrerae Epling					[4]	sh	PE	subg. *Calosphace*, sect. *Secundae*
hidalgensis Miranda					2–9	ss	MX	subg. *Calosphace*, sect. *Hidalgenses*
hilarii Benth.					6–10	sh	BR	subg. *Calosphace*, sect. *Nobiles*
hirta Kunth					[5–7]	sh	PE, EC	subg. *Calosphace*, sect. *Cylindriflorae*
hirtella Vahl	absent			2	4–12	ph	EC	subg. *Calosphace*, sect. *Phoeniceae*
holwayi S. F. Blake	absent			4	3–7	ph, ss (sometimes sc)	MX, GT, CR	subg. *Calosphace*, sect. *Holwaya*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
integrifolia Ruiz & Pav.					4–6	sh	PE	subg. *Calosphace*, sect. *Cylindriflorae*
involucrata Cav.	whitish/pink areas	27.8 ± 1.2 (26.2–30.2), n = 20	1	2–3	5–9	ph	MX	subg. *Calosphace*, sect. *Holwaya*
iodantha Fernald	absent	23.1 ± 1.3 (21–25.8), n = 20	m	2	2–4	ph, ss	MX	subg. *Calosphace*, sect. *Iodanthae*
iodophylla Epling					[5–6]	? (ah/ph or sh)	MX	subg. *Calosphace*, sect. *Iodophyllae*
itaguassuensis Brade & Barb. Per.						ss	BR	subg. *Calosphace*, sect. *Curtiflorae*
iuliana Epling					to 15	ph	VE	subg. *Calosphace*, sect. *Nobiles*
jorgehintoniana Ramamoorthy ex B. L. Turner					[mostly 10–15]	ph	MX	subg. *Calosphace*, sect. *Curtiflorae*
karwinskii Benth.	absent			3	8–15	ss (sometimes sc), sh	MX, GT, SV, HN, NI	subg. *Calosphace*, sect. *Holwaya*
lachnaioclada Briq.				2	1–4	sh	HT, DO	subg. *Calosphace*, sect. *Ekmania*
lachnostoma Epling						sh	PE	subg. *Calosphace*, sect. *Longiflorae*
lanicaulis Epling & Játiva					5–6	sh	PE	subg. *Calosphace*, sect. *Cylindriflorae*
lasiantha Benth.	absent			2–3	1–4	sh	MX, GT, CR	subg. *Calosphace*, sect. *Mitratae*
lavendula Alain					4	sh	DO	subg. *Calosphace*
leucantha Cav.	absent			2	2–3	ph, ss	MX	subg. *Calosphace*, sect. *Albolanatae*
leucocephala Kunth	absent				[2–4]	sh	EC	subg. *Calosphace*, sect. *Leucocephalae*
libanensis Rusby					5–25	sh	CO	subg. *Calosphace*, sect. *Erythrostachys*
lineata Benth.	absent			2	3–4	ph	MX	subg. *Calosphace*, sect. *Fulgentes*
littae Vis.	absent			2	1–3	ph, ss	MX	subg. *Calosphace*, sect. *Purpureae*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
lobbii Epling					5–7	sh	EC, PE	subg. *Calosphace*, sect. *Siphonanthae*
longibracteolata E. P. Santos						ss	BR	subg. *Calosphace*, sect. *Secundae*
longistyla Benth.	absent	25.9 ± 1.6 (20–28), n = 22	1	3–4	6–17	ph, ss, sh	MX	subg. *Calosphace*, sect. *Curtiflorae*
macrocalyx Gardner					5–8	sh	BR	subg. *Calosphace*, sect. *Nobiles*
macrophylla Benth.	absent	24 ± 1.4 (20.5–26), n = 15	27.7 ± 1.6 (26.5–29.5), n = 3; 1	3	4–7	ss	CO, EC, BO, PE	subg. *Calosphace*, sect. *Hastatae*
madrensis Seem.	absent			3–4	9–16	ph	MX	subg. *Calosphace*, sect. *Longipes*
marci Epling					[3–7]	ph, ss, sh	MX	subg. *Calosphace*, sect. *Peninsulares*
mattogrossensis Pilg.						sh	BR	subg. *Calosphace*, sect. *Secundae*
medusa Epling & Játiva					15–32(40)	ss	PE	subg. *Calosphace*, sect. *Siphonanthae*
melaleuca Epling					3–15	ss, sh	CO	subg. *Calosphace*, sect. *Rubescentes*
melissiflora Benth.					2–5	ph	BR	subg. *Calosphace*, sect. *Secundae*
mentiens Pohl						ph	BR	subg. *Calosphace*, sect. *Curtiflorae*
microphylla Kunth	white/light areas or absent			3	2–5	ph, ss, sh	MX, US, GT?	subg. *Calosphace*, sect. *Fulgentes*
miniata Fernald	absent			2	2–4	sh	MX, GT, BZ	subg. *Calosphace*, sect. *Silvicolae*
neovidensis Benth.					3–4	ph	BR	subg. *Calosphace*, sect. *Curtiflorae*
nervata M. Martens & Galeotti	absent			3	3–5	sh	MX, GT	subg. *Calosphace*, sect. *Curtiflorae*
nigrescens Alain (nom. illeg.)					3–8	sh	CU	subg. *Calosphace*
oaxacana Fernald	absent			1	[2–3]	sh	MX	subg. *Calosphace*, sect. *Conzattiana*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
ombrophila Dusén					3–5	sh	BR	subg. *Calosphace*, sect. *Tubiflorae*
oppositiflora Ruiz & Pav.	absent		1	2–3	4–8	ph, ss	PE	subg. *Calosphace*, sect. *Biflorae*
orbignaei Benth.	absent or white/ light area	30 ± 2.2 (25.2–37.8), n = 66	20.3 ± 4.6 (13–28.5), n = 13; 1	3	4–19	ss	BO	subg. *Calosphace*, sect. *Pavonia*
orthostachys Epling					2–4	ph, ss	CO	subg. *Calosphace*, sect. *Rubescentes*
oxyphora Briq.	absent, rarely (?) white area	31.8 ± 2 (28.2–38.6), n = 30	30.3 ± 9.7 (20–53), n = 19; 1	2–4	3–4	ph	BO	subg. *Calosphace*, sect. *Tuberosae*
pealealis Epling					[2–4]	ph	MX	subg. *Calosphace*, sect. *Pedicellata*
paramicola Fern. Alonso						ph	CO	subg. *Calosphace*, sect. *Rubescentes*
paryskii Skean & Judd				2–3	3–8	sh	HT	subg. *Calosphace*, sect. *Ekmania*
patens Cav.	white spots, stripes, also pale	24.9 ± 3.5 (10.4–30.3), n = 38	1	2–3	5–9	ph	MX	subg. *Calosphace*, sect. *Blakea*
pauciserrata Benth.	absent	24.8 ± 1.2 (22.8–28), n = 20	13.8 ± 4.9 (9–20), n = 5; 1	2–3	3–10	ss, sh	CO, PE, EC, VE, CR	subg. *Calosphace*, sect. *Flexuosae*
pavonii Benth.					3–6	ss	PE	subg. *Calosphace*, sect. *Punctatae*
peninsularis Brandegee					[5–6]	ph, ss, sh	MX	subg. *Calosphace*, sect. *Peninsulares*
pentstemonoides Kunth & C. D. Bouché						ph	US	sect. *Eusphace*/related to sect. *Salviastrum*
persicifolia A. St.-Hil.						sh	BR	subg. *Calosphace*, sect. *Nobiles*
phaenostemma Donn. Sm.					8–10	sh	GT	subg. *Calosphace*, sect. *Sulcatae*
pichinchensis Benth.	white area				8–10	ph, sh	EC	subg. *Calosphace*, sect. *Siphonanthae*
plumosa Ruiz & Pav.					[10–15]	ss	PE	subg. *Calosphace*, sect. *Leonuroideae*
pringlei B. L. Rob. & Greenm.					5	ss	MX	subg. *Calosphace*, sect. *Tubiflorae*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
psilantha Epling					4–6	ph	PE	subg. *Calosphace*, sect. *Cylindriflorae*
pubescens Benth.	absent		1	3	2–4	sh	MX	subg. *Calosphace*, sect. *Erythrostachys*
pulchella DC.	absent				3–6	ph, ss	MX	subg. *Calosphace*, sect. *Fulgentes*
quitensis Benth.					5–10	sh	EC	subg. *Calosphace*, sect. *Cylindriflorae*
raveniana Ramamoorthy					[2–3]	ph	MX	subg. *Calosphace*, sect. *Purpureae*
regla Cav.	absent, rarely small white spot			3	1–8	sh, sometimes tr	MX, US	subg. *Calosphace*, sect. *Erythrostachys*
regnelliana Briq.					4–6	ss	BR	subg. *Calosphace*, sect. *Skeptostachys*
rhodostephana Epling					3	ph	PE	subg. *Calosphace*, sect. *Hastatae*
rivularis Gardner ex H. B. Fielding					6–8	sh	BR	subg. *Calosphace*, sect. *Nobiles*
roemeriana Scheele	absent	24.4 ± 3.5 (18.8–32.5), n = 58	1	2	3–4	ph	US, MX	sect. *Heterosphace*
rosei Fernald					[3–5]	sh	MX	subg. *Calosphace*, sect. *Pruinosae*
rubescens Kunth	absent			4	3–12	ss	CO, VE	subg. *Calosphace*, sect. *Rubescentes*
rubrifaux Epling					[4–5]	ph	PE, EC	subg. *Calosphace*, sect. *Cylindriflorae*
rubriflora Epling					2–5	ss	CO	subg. *Calosphace*, sect. *Hastatae*
rufula Kunth					1–5	ss	CO, EC	subg. *Calosphace*, sect. *Killipiana*
rusbyi Britton ex Rusby	absent			2–3	3–6	ss	PE, BO	subg. *Calosphace*, sect. *Cylindriflorae*
sagittata Ruiz & Pav.	white stripes or absent	24.5 ± 2.4 (17.8–31.2), n = 28	6.9 ± 4.1 (2.5–13.5), n = 5; m	2	2–5	ph	PE, CO, EC	subg. *Calosphace*, sect. *Hastatae*
salicifolia Pohl					8–10	sh	BR	subg. *Calosphace*, sect. *Nobiles*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
scabrata Britton & P. Wilson					5	sh	CU	subg. *Calosphace*, sect. *Muricatae*
scabrida Pohl					3–4	ph	BR	subg. *Calosphace*, sect. *Nobiles*
scandens Epling					[5]	sh (sometimes sc)	PE	subg. *Calosphace*, sect. *Weberbaueria*
sciaphila (J. R. I. Wood & Harley) Fern. Alonso						ph	CO	subg. *Calosphace*, sect. *Carneae*
secunda Benth.					3–4	sh	BR	subg. *Calosphace*, sect. *Secundae*
sellowiana Benth.					4–6	sh	BR	subg. *Calosphace*, sect. *Nobiles*
sessei Benth.	absent		1	2–3	2–7	sh, sometimes tr	MX	subg. *Calosphace*, sect. *Erythrostachys*
sigchosica Fern. Alonso	white stripes				3–4	ph or ss	EC	subg. *Calosphace*, sect. *Siphonanthae*
spathacea Greene	absent	20 ± 5.34 (6.8–25.4), n = 23	32.6 ± 16.3 (13–51), n = 10; 1	2–4	0–2	ph	US	sect. *Audibertia*
speciosa C. Presl ex Benth.					8–15	ss	PE	subg. *Calosphace*, sect. *Macrostachyae*
speirematoides C. Wright					[5]	sh	CU	subg. *Calosphace*, sect. *Brittonia*
splendens Sellow ex Roem. & Schult.	absent		1	4	5–6	ph	BR	subg. *Calosphace*, sect. *Secundae*
sprucei Briq.	white area or absent				8–10	sh	EC	subg. *Calosphace*, sect. *Cylindriflorae*
squalens Kunth	absent or pale whitish area		1	3	6–7	ph	PE, EC	subg. *Calosphace*, sect. *Biflorae*
stolonifera Benth.				2	2–4	ph	MX	subg. *Calosphace*, sect. *Holwaya*
striata Benth.	absent	21.2 ± 1.8 (17.6–23.1), n = 22	1	2–3	3–9	ss	PE	subg. *Calosphace*, sect. *Biflorae*
subhastata Epling					10–12	ph to sh	MX	subg. *Calosphace*, sect. *Sphacelioides*
subrotunda A. St.-Hil. ex Benth.	white spots/stripes (always?)				3–6	ah	BR, PY, AR	subg. *Calosphace*, sect. *Subrotundae*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
subrubens Epling					6–7	? (ph or ss or sh)	GT	subg. *Calosphace*, sect. *Floridae*
summa A. Nelson	absent, or white/ pink-purple dots			1–2	6	ph	US, MX	sect. *Heterosphace*
tenuiflora Epling					4–5	sh	BR	subg. *Calosphace*, sect. *Curtiflorae*
thormannii Urb.				2	2–6	sh	DO	subg. *Calosphace*, sect. *Ekmania*
tolimensis Kunth						ss	CO	subg. *Calosphace*, sect. *Purpureae*
tomentella Pohl					[3]	ph	BR	subg. *Calosphace*, sect. *Albolanatae*
tortuosa Kunth					3–5	sh	CO, EC	subg. *Calosphace*, sect. *Tubiflorae*
townsendii Fernald					2–4	ph	MX	subg. *Calosphace*, sect. *Iodanthae*
trachyphylla Epling					4–6	sh	EC	subg. *Calosphace*, sect. *Cylindriflorae*
tubifera Cav.	absent			2	1–2	ph, ss	MX, GT	subg. *Calosphace*, sect. *Curtiflorae*
tubiflora Sm.					5–7	ph, ss	PE, CL	subg. *Calosphace*, sect. *Biflorae*
tubulosa Epling						sh	PE	subg. *Calosphace*, sect. *Longiflorae*
tuerckheimii Urb.				3	2–9	sh	DO	subg. *Calosphace*, sect. *Ekmania*
uncinata Urb.				2–3	2–10	sh	DO	subg. *Calosphace*, sect. *Ekmania*
unguella Epling					[5]	ss	EC	subg. *Calosphace*, sect. *Secundae*
univerticillata Ramamoorthy ex Klitg.	absent		1	2	4–7	ph	MX	subg. *Calosphace*, sect. *Holwaya*
venulosa Epling					6–7	ss	CO	subg. *Calosphace*, sect. *Tubiflorae*

Table 1B. Continued.

Salvia spp.	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*	Nectary length, mm	Pedicel length, mm	Growth form*	Distribution*	Taxonomic position
verapazana B. L. Turner					4–6	ph (?)	GT	subg. *Calosphace*
vestita Benth.						ss, sh	PE probably	subg. *Calosphace*, sect. *Longiflorae*
wagneriana Pol.	whitish/pink area			3	2–10	ph, ss	MX, GT, SV, NI, CR, PA	subg. *Calosphace*, sect. *Holwaya*
weberbaueri Epling					6–9	sh	PE	subg. *Calosphace*, sect. *Longiflorae*
xanthotricha Harley ex E. P. Santos					4–5	ss	BR	subg. *Calosphace*, sect. *Secundae*
xeropapillosa Fern. Alonso					[2–5]	ph	CO	subg. *Calosphace*, sect. *Rubescentes*
Mean and SD		26.2 ± 4.6	18.6 ± 9.8	2.6 ± 0.7	5.9 ± 3.4			
Minimum and maximum		6.8–62	2–53	1–5	0–34(40)			
n		27	13	72	162			

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* Refers to the following classification (see Methods): **Nectar concentration** (average, SD, range). **Nectar volume** (average, SD, range): m = medium (about 3–10 µl), l = large (> 10 µl). **Growth form**: ah = annual herb, ph = perennial herb, ss = subshrub, sh = shrub, tr = small tree, sc = scandent. **Countries**: Argentina = AR, Belize = BZ, Bolivia = BO, Brazil = BR, Chile = CL, Colombia = CO, Costa Rica = CR, Cuba = CU, Dominican Republic = DO, Ecuador = EC, El Salvador = SV, Guatemala = GT, Haiti = HT, Honduras = HN, Mexico = MX, Nicaragua = NI, Panama = PA, Paraguay = PY, Peru = PE, United States of America = US, Uruguay = UY, Venezuela = VE. Square brackets = preliminary data. Blank cells signify no data were available.

1B, C, E, F). In 11 species the position of the thecae is variable (Table 1A, B).

Flower scent. No noticeable flower scent was found.

Pedicels. The pedicels are mostly flexible, and their length ranges from 34 mm in *Salvia dombeyi* to being absent in *S. spathacea*.

Growth form. As to the growth form, almost all bird-pollinated *Salvia* species (97%) are perennial herbs, subshrubs, or shrubs. Only *S. exserta* and *S. subrotunda* A. St.-Hil. ex Benth. are annuals, while *S. coccinea* Buc'hoz ex Etl. varies from annual to perennial. Three species (*S. dombeyi*, *S. regla*, *S. sessei* Benth.) are scandent subshrubs, shrubs, or sometimes small trees.

Distribution. The ornithophilous sages show a wide distribution in the New World, reaching from California to Chile and Argentina (Fig. 5, Table 1A, B). Comparing the different countries, Mexico has the largest number of ornithophilous species (57 to 58 spp.) and ornithophilous endemics (41 to 42 spp.). However, considering the total number of *Salvia* species within the country (about 300 spp., the largest species number within a single country), the relative percentage of the ornithophilous species is relatively low (about 19%) compared to other countries.

Centers of diversity for the bird-pollinated species of *Salvia* are (Fig. 5): (1) the central and southern highlands of Mexico and Guatemala; (2) the northern part of the South American Andes (Colombia, Ecuador, Peru, the latter two with about half of the species being bird pollinated); and (3) the southern part of Brazil with more than 50% bird-pollinated species (especially southeastern Brazil, with 25 of the 35 Brazilian species, all endemic to the country). The ornithophilous species in Cuba and Hispaniola (including Haiti and the Dominican Republic) are also all endemic. Relative to a country area, El Salvador, Guatemala, Haiti, and the Dominican Republic have the highest density of ornithophilous sages by species number.

Habitat. Bird-pollinated *Salvia* species occur in all habitats from rainforests to at least mesic habitats in deserts from ca. 200 to 4000 m in elevation. They mainly occur in the highlands of the American cordilleras at elevations from ca. 1500 to 3000 m, and in southeastern Brazil from ca. 1000 to 1500 m.

Systematics. In terms of systematics, most of the New World ornithophilous sages belong to the widespread group *Salvia* subg. *Calosphace* (179 spp. in 56 sections). Three species (*S. henryi* A. Gray, *S. roemeriana* Scheele, *S. summa* A. Nelson) belong to *Salvia* sect. *Heterosphace* Benth. (Arizona to central Mexico), *S. spathacea* (California) to section *Audibertia* (Benth.) Epling, and *S. pentstemonoides* Kunth & C. D. Bouché (Texas) to section *Eusphace* Benth. (see Table 1A, B).

MELITTOPHILOUS SPECIES

Most of the New World sages allow bees to pollinate the flowers (58%; Appendix 2, Fig. 6A–I). Because their flowers correspond in their proportions with bees, provide a landing platform, have in general short corolla tubes, and deposit pollen on the bee's body, we classify them as melittophilous. Altogether, 65 species of this group were seen as living plants (33 at natural localities, 54 cultivated in botanical gardens and nurseries). Pollinating bees were observed at *Salvia stachydifolia* C. Presl ex Benth., *S. rypara* Briq. subsp. *platystoma* (Epling) J. R. I. Wood, *S. cuspidata* Ruiz & Pav. subsp. *bangii* (Rusby) J. R. I. Wood, *S. sophrona* Briq., *S. carduacea* Benth., *S. apiana* Jeps., *S. mellifera* Greene, *S. leucophylla* Greene, *S. dorrii* (Kellogg) Abrams, *S. munzii* Epling, *S. columbariae* Benth., and other species not listed in detail.

Flowers of this group share the following traits:

Corolla tube length. The corolla tube is short ($\leq$ 2 cm), enabling the bees to reach the nectar at the base of the corolla.

Corolla color. The color of the corolla is often blue and violet, but also white, pink, purple (Fig. 6A–I), or rarely yellowish. Nectar guides are often found at the flower entrance (Fig. 6C, G, H).

Staminal connectives. A peculiar feature of many bee-pollinated *Salvia* species in subgenus *Calosphace* is the presence of distinct ventral teeth or barriers at the connectives. The latter may be large and contribute to occlude the entrance. In *S. rypara* subsp. *platystoma* (Fig. 6D) and *S. pusilla* Fernald, for example, the lever mechanism is triggered by pushing back these barriers. In species like *S. amplifrons* Briq. and *S. cuspidata* subsp. *bangii*, the ventral formations are laterally arranged.

Pollen sacs. The pollen sacs of most species are enclosed by the upper lip (Fig. 6A–D, I). Exceptions (exposed pollen sacs) are found in all species of sections *Echinosphace* Benth. (Fig. 6E, G) and *Audibertia* (Fig. 6F, H), and in very few species of

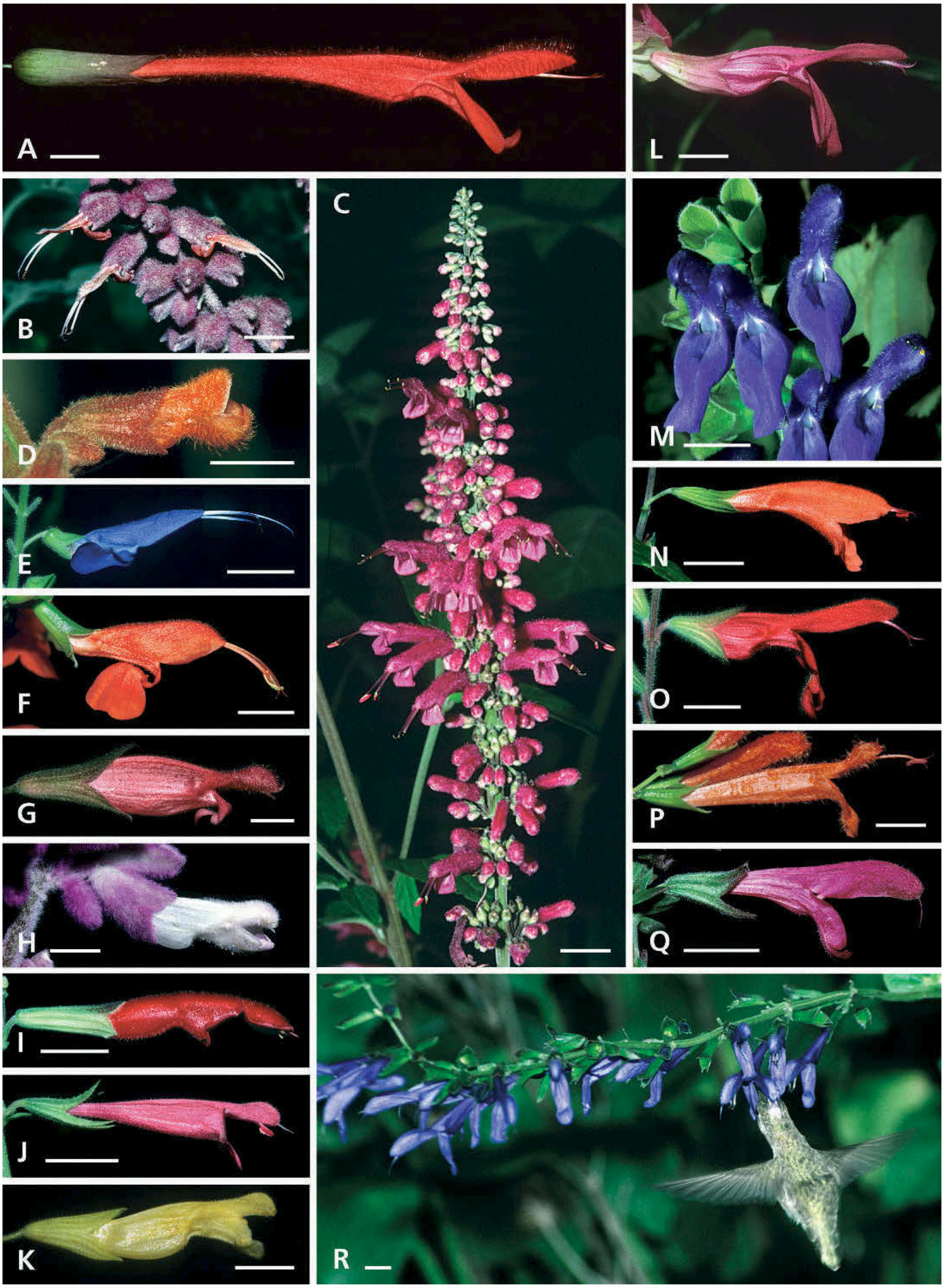

Figure 1. Diversity of ornithophilous *Salvia* flowers. —A. *S. dombeyi* with the largest flower in the genus. —B. *S. lasiantha*, view of inflorescence, with flowers having greatly exserted thecae and reflexed lower lips. —C. *S. iodantha* inflorescence bearing long-tubed flowers with greatly exserted thecae. —D. *S. confertiflora* flower with cup-shaped lower lip. E, F. Flowers with reflexed lower lips and greatly exserted thecae. —E. *S. macrophylla*. —F. *S. pauciserrata*. —G. *S. karwinskii*, elliptic in outline with reflexed lower lip. —H. *S. leucantha* flower with antrorse lower lip lengthening the corolla tube. —I. *S. nervata* flower tubular with very short lower lip. J, K. Relatively long-tubed flowers. —J. *S. henryi*, usually red. —K. *S. madrensis*.

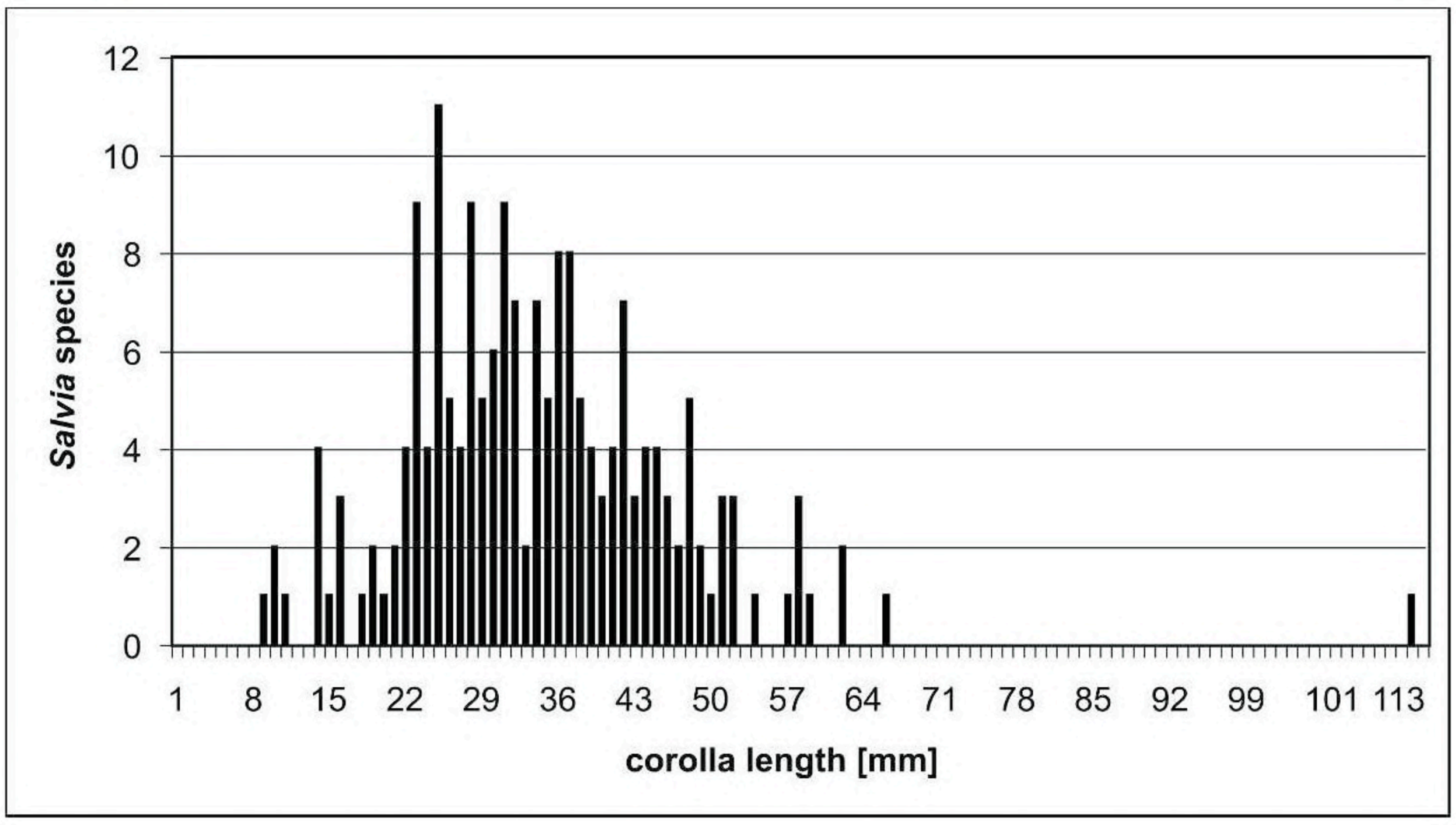

Figure 2. Corolla length in ornithophilous *Salvia* species. Lengths were calculated from the average of the minimum and maximum values listed in Table 1A and B. Sample size, n = 184.

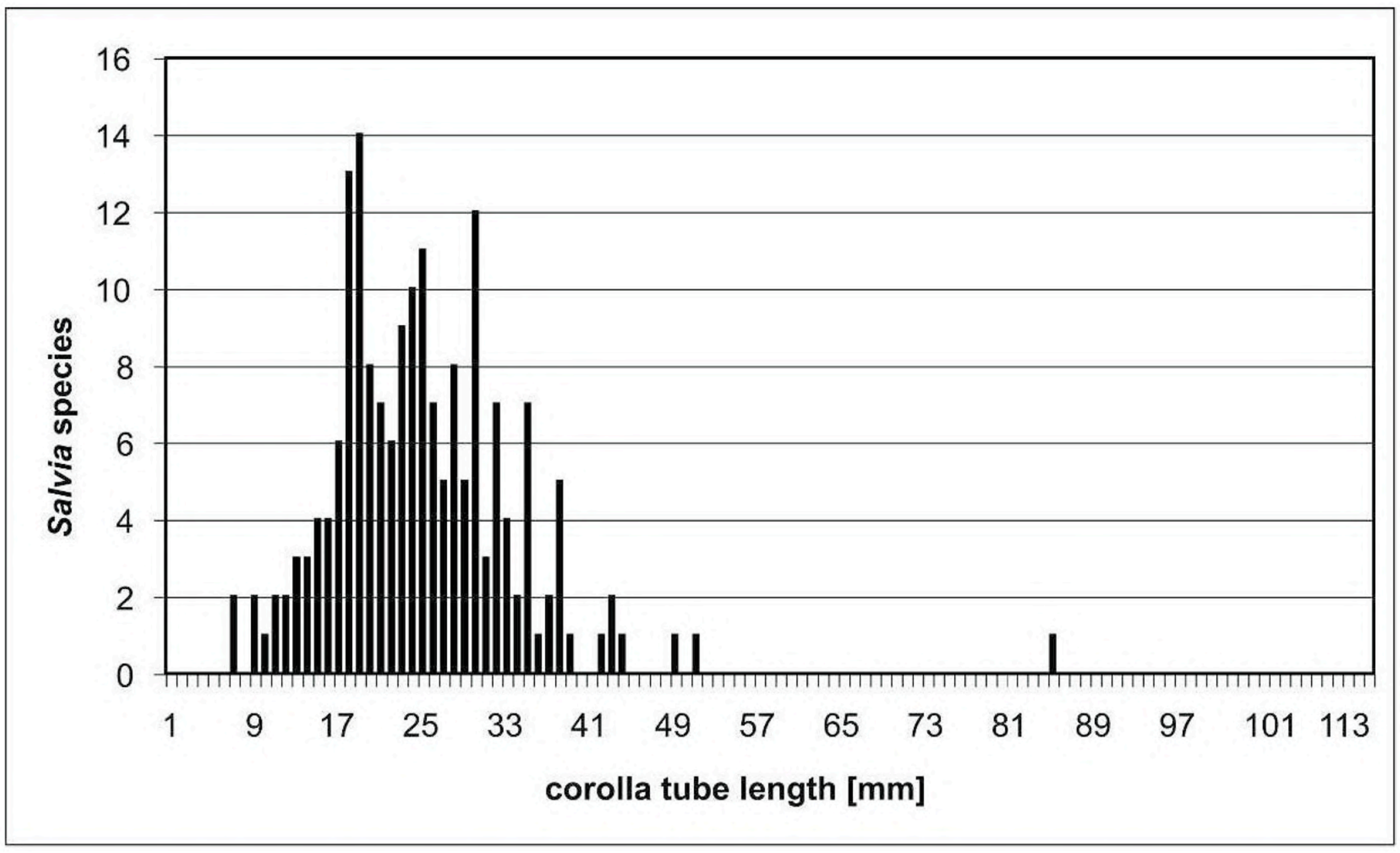

Figure 3. Corolla tube length in ornithophilous *Salvia* species. Lengths were calculated from the average of the minimum and maximum values listed in Table 1A and B. Sample size, n = 183.

Salvia subg. *Calosphace* (e.g., *S. rhombifolia* Ruiz & Pav., *S. tafallae* Benth., *S. palifolia* Kunth, *S. paposana* Phil.).

Staminal lever mechanism. Usually, the staminal lever mechanism is functional (e.g., *Salvia stachydifolia*, *S. texana* (Scheele) Torr., *S. rypara* subsp. *platystoma*). It is lacking only rarely, as for instance in *S. carduacea* or *S. apiana*.

Connivent lips at flower entrance. In *Salvia betonica* Schult. and *S. lavanduloides* Kunth (section *Lavanduloideae* Epling of *Salvia* subg. *Calosphace*), the flower entrance is more or less closed and

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←
L, M. Bilabiate flowers with long tubes and large lips. —L. *S. gravida.* —M. *S. atrocyanea.* —N. *S. oppositiflora* flower funnelform with slightly exserted thecae. —O. *S. oaxacana* flower with deflexed lower lip. —P. *S. rusbyi* flower long-tubed with exserted thecae (the species also has individuals with thecae enclosed by the upper lip). —Q. *S. pentstemonoides* flower bilabiate with tube of medium length and relatively long upper lip. —R. *S. guaranitica* visited by the hovering hummingbird *Calypte costae* with thecae and pollen on the bird's head. Scale bars: A–C, E, F, I–R = 1 cm; D, G, H = 0.5 cm.

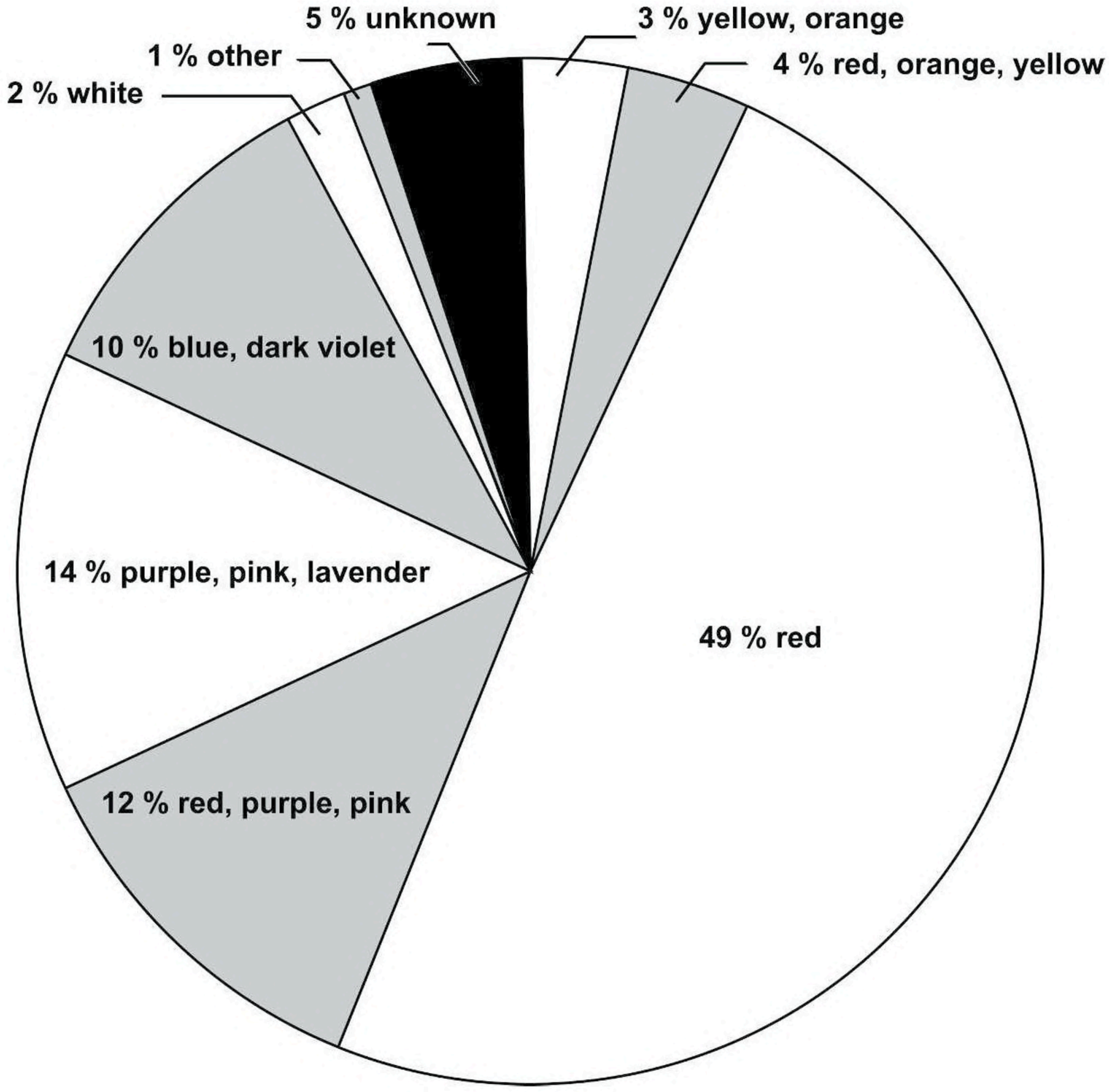

Figure 4. Corolla color of ornithophilous *Salvia* species (see Table 1A, B).

concealed by connivent lips (Fig. 6I), a feature not found in ornithophilous sages.

Arrangement of flowers. The flowers of the species investigated are usually flexibly arranged (e.g., *Salvia amplifrons*, *S. uliginosa* Benth., *S. rypara* subsp. *platystoma*), but stable enough to bear the bees' weight. If they are more stiffly arranged, they may have shorter (and more stable) pedicels or may be densely arranged in the inflorescence (e.g., *S. betonica*, *S. dorrii*, *S. leucophylla*).

Nectaries and nectar. Nectaries are in general smaller than those in ornithophilous flowers, producing only small amounts of highly concentrated nectar (e.g., *Salvia stachydifolia*, *S. rypara* subsp. *platystoma*).

Flower scent. No noticeable flower scent was found in the species examined, except a honeylike or sweetish scent in *Salvia leucophylla*, *S. apiana*, *S. californica* Brandegee, and *S. carduacea*.

Nonpollinating visitors. Hummingbirds were (rarely) observed to visit the flowers (*Salvia* cf. *longispicata* M. Martens & Galeotti). In addition to pollinators, nectar-stealing and/or pollen-stealing bees were observed at, e.g., *S. rypara* subsp. *platystoma*, *S. stachydifolia*, *S. apiana*, and *S. carduacea*, nectar-stealing butterflies at *S. engelmannii* A. Gray, *S. leucophylla*, *S. columbariae*, and *S. carduacea*, and a hawkmoth at *S. carduacea*.

Distribution. Compared to ornithophilous species, the bee-pollinated sages have a wider distribution and are more abundant (e.g., in Mexico and the United States, in Argentina, Paraguay, and Panama; Fig. 5). They show a wider altitudinal range, but mainly occur in slightly lower elevations than the ornithophilous species (for instance, in Colombia and Ecuador and at least some areas in Mexico, such as the Sierra Manantlán and the Valle de México, and Brazil).

PSYCHOPHILOUS SPECIES

Salvia whitehousei Alziar (section *Salviastrum* (Scheele) Gray) definitely excludes bees by its very long (34.8 ± 4.4 mm, range 26–44 mm, n = 33 flowers) and relatively narrow corolla tube (Fig. 6J). The flowers also differ in color, shape, and symmetry from ornithophilous ones. They are basically mono-

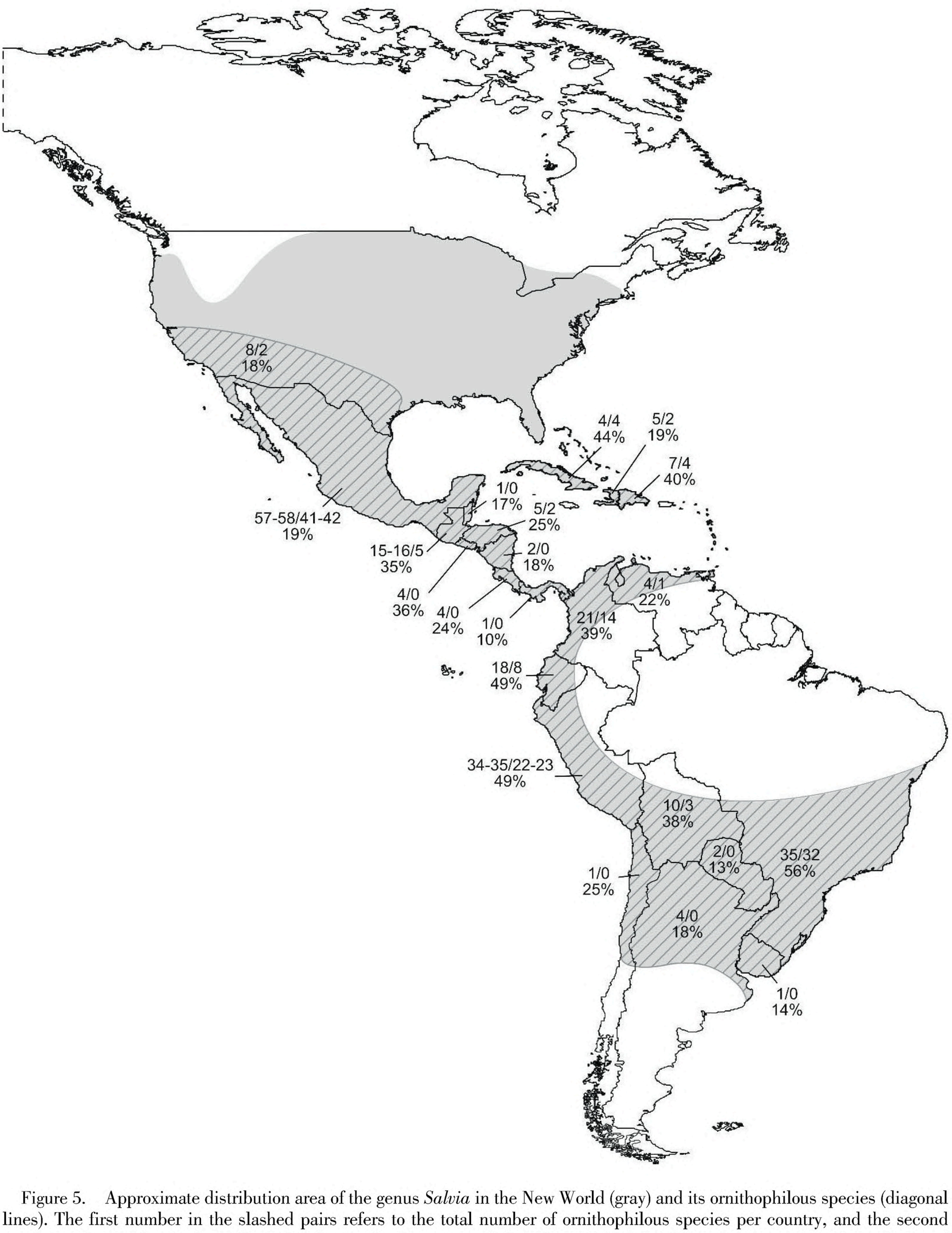

Figure 5. Approximate distribution area of the genus *Salvia* in the New World (gray) and its ornithophilous species (diagonal lines). The first number in the slashed pairs refers to the total number of ornithophilous species per country, and the second number refers to the total number of endemics in that group. Below these paired numbers, the approximate percentage of ornithophilous species per country is indicated. Note that the widespread *S. coccinea* (southern United States to southern South America) is not considered because its natural distribution is unclear (perhaps Mexico/Central America or Brazil).

symmetrical, but almost radial in appearance because all petal lobes spread at a right angle, forming a disc at the end of the corolla tube (lobes 7–13 mm long). The flowers are light pink to lavender (color values: C10–30 M10–50 S00) with two white spots below the flower entrance most likely acting as nectar guides. The thecae in the flower entrance are whitish and thus likewise conspicuous. The staminal joint is functional, but the connective arms are too short to block the entrance for an insect's proboscis. A light,

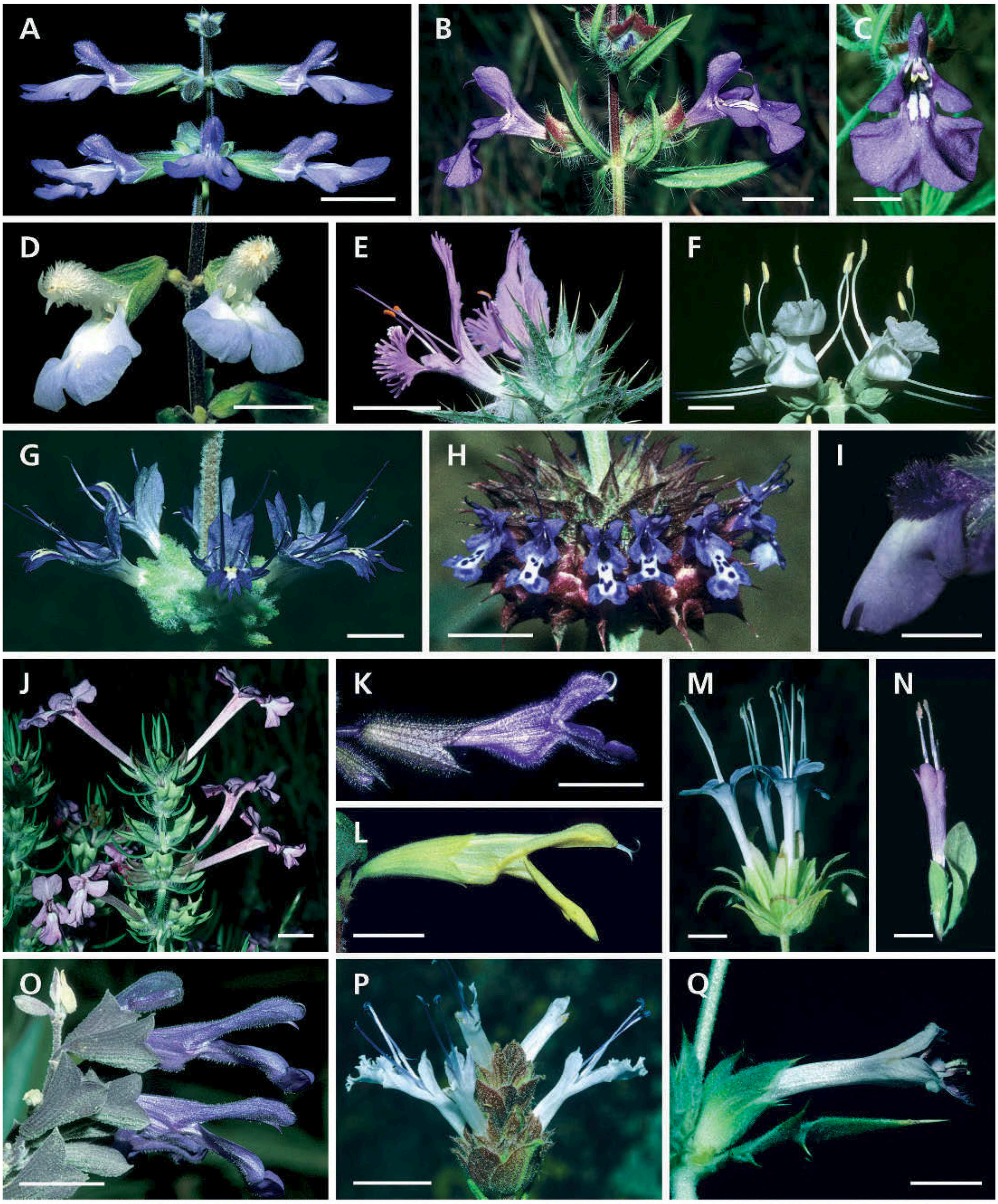

Figure 6. Diversity of *Salvia* flowers, being melittophilous (A–I), psychophilous (J), and not clearly assignable to a syndrome (K–Q). —A. *S. stachydifolia* flowers with pollen sacs enclosed by the upper lip, short corolla tubes, and large lower lips as landing platform. —B, C. *S. texana* flowers with large lower lips possessing white nectar guides. —D. *S. rypara* subsp. *platystoma* flowers short-tubed, showing large connective outgrowths in the flower entrance. E–H. Flowers with exposed thecae and large lower lips. —E. *S. carduacea*. —F. *S. apiana*. —G. *S. californica*. —H. *S. columbariae*, the latter two with white and patterned nectar guides on the lower lips. —I. *S. betonica* flower entrance more or less closed and concealed by connivent lips. —J. *S. whitehousei* inflorescence view bearing long-tubed salverform flowers with white nectar guides. K, L. Flowers with melittophilous and ornithophilous characters. —K. The variably sized *S. concolor* flower. —L. *S. aspera*. —M, N. *S. mohavensis* flowers with ornithophilous and psychophilous characters, having long, narrow corolla tubes, lips spreading at a right angle to the tube (M), and exserted thecae, varying sometimes in the width of the corolla tube, orientation of corolla lips, and corolla color (N). —O. *Salvia retinervia* flowers with melittophilous and ornithophilous characters, looking more melittophilous, but variable in corolla tube length with a relatively large volume of nectar. —P. *Salvia eremostachya* flowers with melittophilous, psychophilous, and ornithophilous characters. —Q. *Salvia greatae* flower with melittophilous and psychophilous characters. Scale bars: A, B, E, H, J–L, O, P, = 1 cm; C, D, F, G, M, N, Q = 0.5 cm; I = 0.25 cm.

more or less fruity scent of the corolla and the calyx was detected. Nectar of medium volume was found protruding 5–11 mm into the tube.

Although several populations were studied at roadside localities in western Texas, no pollinators were seen. Nevertheless, we deduce from the floral traits and proportions, tube dimensions, and landing platform that butterflies and/or long-tongued flies are the pollinators of the species.

REMAINING SPECIES

The remaining New World *Salvia* species (Appendix 2) share characters with species of different groups and thus allow different pollinator guilds access to nectar (see Table 2) or are too little known to be characterized sufficiently.

Species probably pollinated by bees and birds. *Salvia purpurea* Cav. (*Salvia* subg. *Calosphace*; Table 2) has highly variable flowers with different corolla colors, flower sizes, and proportions of tube to lower lip length (sometimes even within one individual). Long-tubed flowers with relatively short lower lips allow birds access to the nectar, but exclude bees. Flowers with longer lower lips, offering a better landing platform for bees, may be pollinated by both birds and bees. Indeed, field observations in Mexico confirmed that hummingbirds (hovering and perching) and bees visit the flowers, being dusted with pollen. Bees were also found as nectar and pollen thieves and different species of butterflies and hawkmoths stole nectar. Additonally, studies in Mexico showed that the activity of flower visitors varied. At some places hummingbirds were more frequent (Guadalajara); at other localities bees were more abundant (Xalapa).

The yellow flowers of *Salvia aspera* M. Martens & Galeotti (*Salvia* subg. *Calosphace*; Fig. 6L; Table 2) also vary in length. Although the larger flowers with a relatively large volume of nectar with medium sugar concentration may attract birds, the smaller ones may also allow bees access to nectar. Their lower lips are relatively narrow, but stable enough to present a landing platform for bees.

The dark violet corolla of *Salvia concolor* Lamb. ex Benth. (*Salvia* subg. *Calosphace*; Fig. 6K; Table 2) offers a large landing platform for bees at its lower lip. However, the long corolla tube probably excludes bees from nectar. The medium amount of nectar with its relatively low sugar concentration also indicates bird pollination. We assume that bees might reach the nectar in short-tubed flowers, but are excluded in longer ones.

Salvia mexicana L. (*Salvia* subg. *Calosphace*; Table 2) is a quite variable species with two varieties, *S. mexicana* var. *minor* Benth. and *S. mexicana* var. *major* Benth. In general, the varieties considerably differ in corolla size, in the proportion of tube to lower lip length, and in the lower lip position. Additionally, these characters and the corolla color differ within the varieties and overlap. The large flowers in both varieties and the flowers with a relatively short lower lip in comparison to the flower tube are clearly ornithophilous as they exclude bees from nectar. Smaller flowers, especially those with long lower lips, are thought to be intermediate and/or pollinated by bees. Nectar data of the examined individuals in both varieties might be rather attractive to birds. Indeed, at the lighter violet flowers of *S. mexicana* var. *major*, hummingbirds were observed visiting the flowers, while bees stole nectar.

The following three species have small- to medium-sized corolla tubes and large lower lips that clearly allow bees access to nectar. The blue *Salvia scutellarioides* Kunth (*Salvia* subg. *Calosphace*; Table 2) with white nectar guides on the lower lips and rather short corolla tubes has a medium volume of nectar with a relatively low sugar concentration. Furthermore, flowers have exposed thecae that might not be touched by bees. *Salvia discolor* Kunth (*Salvia* subg. *Calosphace*; Table 2), with a dark violet (almost black) corolla contrasting to the whitish green calyx, corresponds to the bee-pollinated flowers in its large lower lip, short- to medium-sized tube, and nectar of high sugar concentration. However, nectar guides are lacking and the large volume of nectar might also attract birds. *Salvia retinervia* Briq. (*Salvia* subg. *Calosphace*; Table 2; Fig. 6O), with a dark violet tube of variable length, also has a relatively large volume of nectar, which might be attractive to birds. In Bolivia, large bees were observed to pollinate the species, whereas other bee species stole nectar.

Species probably pollinated by birds and butterflies/long-tongued flies. In contrast to the above-mentioned species, *Salvia mohavensis* Greene (Fig. 6M) and *S. clevelandii* (A. Gray) Greene (both *Salvia* sect. *Audibertia*; both Table 2) exclude bees due to their long and narrow corolla tubes and exserted thecae. Their medium volume of nectar with a medium to low sugar concentration corresponds to this finding.

The blue to blue-violet flowers of *Salvia clevelandii* have a strong sweet scent that might be attractive to butterflies. Although butterflies were indeed observed at the flowers (Rancho Santa Ana Botanic

Table 2. Characteristics of selected *Salvia* species with intermediate characters.

Salvia spp.	Corolla length, mm	Corolla tube length, mm	Lower lip length, mm	Lower lip position*	Flower shape*
purpurea Cav.	(12)19–36	(9)12–21	(3)7–11	a, rarely d	b
aspera M. Martens & Galeotti	23–40	13–26	13–17	a, rarely d	b
concolor Lamb. ex Benth.	22–34	14–27	8–10	a	b
mexicana L.	var. *major*: 28–49; var. *minor*: 15–29	var. *major*: 18–29; var. *minor*: 11–20	var. *major*: 9–17; var. *minor*: 5–11	var. *major*: a or d; var. *minor*: a	b
scutellarioides Kunth	16–25	10–16	8–12	a	b
discolor Kunth	20–30	13–19	8–16	a	b
retinervia Briq.	21–30	12–20	11–14	a	b
clevelandii (A. Gray) Greene	18–29	12–20	4–6	a, ah	± t
mohavensis Greene	moh.: 19–30; Pinacate form: 17–25	moh.: functional tube: 16–25; Pinacate form: 16–22	moh.: 4–7; Pinacate form: (3)4–5	moh.: d; Pinacate form: ah, lc	moh.: s; Pinacate form: t
eremostachya Jeps.	18–25	12–17	9–13	a	± t
greatae Brandegee	13–20	8–13	3–7	a	t

Table 2. Extended.

Salvia spp.	Exposition of thecae from upper lip, mm	Corolla color*	Nectar guides on corolla	Nectar concentration, %*	Nectar volume, µl*
purpurea Cav.	0	Pi to Pu or Vi C20–70 M50–99 S00–10, rarely liPi C00 M10 S00 or Wh C00 M00 S00	absent		
aspera M. Martens & Galeotti	0	Ye Y70–80 M00–05 S00	absent	28.8 ± 1.3 (24.3–31.5), n = 29	l
concolor Lamb. ex Benth.	0	daVi C99 M95 S00	absent	21.2 ± 2.8 (15.2–25.8), n = 33	m
mexicana L.	0	var. *major* and var. *minor*: daVi C90–99 M80–90 S00–20, var. *major*: sometimes also meVi and liVi C60–90 M50–80 S00 or whitish C00–10 M00–10 S00; calyx blackish to green and yellowish	absent	var. *major*: 18.7 ± 5 (9–26), n = 34; var. *minor*: 27.3 ± 3.1 (20.5–36), n = 61	var. *major*: mostly l; var. *minor*: m to l
scutellarioides Kunth	(4–7)	Bl C99 M80 S00	white	23.7 ± 2.1 (19–34.4), n = 59	4.5 ± 1.2 (2–7.5), n = 29; m
discolor Kunth	0	daVi (almost black) C99 M90 S80–90; calyx whitish light green	absent	> 40 (19.4 to > 62), n = 55	21.3 ± 7.7 (11–44), n = 15; l
retinervia Briq.	0	daVi C99 M90 S00	absent		l
clevelandii (A. Gray) Greene	5–9	Bl to BlVi C70–90 M60–80 S00	absent	26 ± 2.4 (20.2–31.6), n = 37	m
mohavensis Greene	8–13 (both forms)	moh.: liBl C20–40(50) M10–30(40) S00, bracts Wh/whitish, rarely with paVi/yellowish; Pinacate form: liPi/Vi/Lav C10–30 M20–50 S00, lips at their inner part C50 M70 S00, bracts green	absent (both forms)	moh.: 19 ± 6.4 (8–37). n = 32	moh.: m
eremostachya Jeps.	4–6	(pale) ViPi to almost Wh C10 M10 S00, C60 M60 S00	absent	17.4 ± 2.9 (14.5–21), n = 6	m
greatae Brandegee	0–3	Pi-Lav (lower lip: C40–50 M60–90, tube: C10–20 M20–40 S00)	sometimes pale whitish		s

Table 2. Extended.

Salvia spp.	Flower scent	Observations of hummingbirds	Reports of hummingbirds	Observations of insects	Reports of insects
purpurea Cav.	no	*Selasphorus rufus*, *Hylocharis leucotis*, *Archilochus* cf. *colubris*, *Cynanthus latirostris* (field, Mexico; hovering and perching)	visited by *Doricha eliza* (Ortiz-Pulido et al., 2002)	visited by various bee species dusted with pollen (e.g., cf. *Eulaema*), visited by other bees, different butterflies, and hawkmoths stealing nectar (field, Mexico)	visited by 5 bee species robbing nectar (Dieringer et al., 1991); visited by *Euglossa atroveneta* drinking nectar (Ramírez & Martínez, 1998)
aspera M. Martens & Galeotti	no				pollinated by bees (possibly only concluded because of corolla color; Ramamoorthy & Elliott, 1998)
concolor Lamb. ex Benth.	no		visited and apparently pollinated by hummingbirds (*Beaman 2068*, MEXU)		
mexicana L.	no	var. *major*: unidentified hummingbirds (field, Mexico; hovering)	both vatieties: visited/ pollinated by hummingbirds (Wagner, 1946; Des Granges, 1979; Geisfield, 1987; Arizmendi et al., 1996; Lara & Ornelas, 2001)	*major*: visited by bees stealing nectar (field, Mexico)	*major* and *minor*: pollinated by *Deltoptila elefas*, other bee species as robbers (Dieringer et al., 1991); bumble bees as pollinators and robbers (Arizmendi et al., 2007); *major*: visited by *Anthophora* sp. (Reisfield, 1987); *minor*: visited by *Bombus nigrodorsalis* robbing nectar (Reisfield, 1987); rarely legitimate bee visits (compared to hummingbirds; C. Lara, pers. comm.)
scutellarioides Kunth	no				visited by *Bombus atrata* (Rasmussen, 2004)
discolor Kunth	no				
retinervia Briq.	no			visited/pollinated by large bees, visited by other bees stealing nectar and pollen (field, Bolivia)	

Table 2. Extended. Continued.

Salvia spp.	Flower scent	Observations of hummingbirds	Reports of hummingbirds	Observations of insects	Reports of insects
clevelandii (A. Gray) Greene	sweet	*Archilochus alexandri* (cult.: Rancho Santa Ana Botanic Garden; hovering)	visited/pollinated by hummingbirds (Cox, 1981; B. O'Brien, pers. comm.)	visited by different bee species robbing nectar (e.g., *Xylocopa* sp., *Apis mellifera*), visited by butterflies (cult.: Rancho Santa Ana Botanic Garden)	visited by hawkmoths (*Hemaris thysbe*), nectar-robbing bees piercing corolla (*Xylocopa* sp., rarely touching reproductive organs), nectar-stealing small bees using these holes (*Apis mellifera*, *Megachile* sp.) (Cox, 1981)
mohavensis Greene	no (both forms)	moh.: hummingbird (cult.: Rancho Santa Ana Botanic Garden; hovering)	Pinacate form: visited by hummingbirds (A. Sanders, pers. comm.)		moh.: visited by long-tongued flies (B. O'Brien & P. Wilson, pers. comm.; Fenster et al., 2004)
eremostachya Jeps.	no		at least occasionally pollinated by hummingbirds (E. Jones, pers. comm.)		
greatae Brandegee	sweetish	hummingbird (cult.: Rancho Santa Ana Botanic Garden; hovering)		visited by a fly (field, U.S.A.)	

* Refers to the following classification (see Methods): **Lower lip position:** d = deflexed, a = antrorse (ah = ± horizontal, not flexed), lc = lower and upper lips close to each other. **Flower shape:** b = bilabiate, t = tubular, s = Stielteller. **Color:** Bl = blue, Lav = lavender, Pi = pink, liPi = light pink, Pu = purple, Vi = violet, Wh = white, Ye = yellow; da = dark, li = light, pa = pale, me = medium. CMYK after Küppers (1999; C: cyan, M: magenta, Y: yellow, K [here S]: black). **Nectar concentration** (average, SD, range). **Nectar volume** (average, SD, range): s = small (< 3 µl), m = medium (about 3–10 µl), l = large (> 10 µl).

Garden), they were not the exclusive visitors as hovering hummingbirds also visited and probably pollinated the flowers. Nectar-robbing bees of different species pierced the flowers at their base.

Salvia mohavensis, studied at different localities in California, has bracts that are partly white or whitish, rarely with pale violet or yellowish areas. The corollas are light blue (Fig. 6M). Their lips form a more or less discoidal and widespread arranged disc, making the flowers only somewhat zygomorphic. Together with the corolla tube this lip formation results in the typical Stielteller shape of the flowers. In the Fullerton Arboretum, hummingbirds were observed visiting the flowers. However, cultivated plants in a private garden in Tucson (M. Dimmitt), originating from an isolated occurrence of the species in northern Mexico (the Pinacate region), have different flowers. The bracts are green and the corolla light pink to violet to lavender. The flowers differ in floral tube width and lip orientation, giving them a tubular shape that lacks a landing platform, and thus are more likely to be visited and pollinated by birds (Fig. 6N).

Species probably pollinated by bees, butterflies/long-tongued flies, and birds. The flowers of *Salvia eremostachya* Jeps. (*Salvia* sect. *Audibertia*, Fig. 6P; Table 2) are (pale) violet-pink to almost white. Their short to medium-sized and relatively narrow corolla tubes and large lower lips allow bees, birds, and butterflies/long-tongued flies access to the nectar. However, the thecae and stigma are exserted and whether or not a visitor is a pollinator is dependent on its body proportions. The nectar of cultivated plants has a relatively low sugar concentration. This might be less attractive for bees, but accepted by birds or butterflies/long-tongued flies.

Species probably pollinated by bees and butterflies/long-tongued flies. The pinkish lavender flowers of *Salvia greatae* Brandegee (*Salvia* sect. *Echinosphace*, Fig. 6Q; Table 2) are small and tubular. They vary in tube length and the relative proportions of tube and lower lips. Bees are assumed to be pollinators of flowers with a shorter tube length, while butterflies or long-tongued flies may be pollinators of the longer-tubed flowers. Once a hummingbird was observed at the flowers (Rancho Santa Ana Botanic Garden), as well as a fly (field, California, U.S.A.), but it is not clear whether they indeed pollinated the flowers. Due to the low volume of nectar and the sweetish scent, bird pollination appears unlikely. The scent might be rather attractive to bees or butterflies.

DISCUSSION

POLLINATION SYNDROMES IN THE NEW WORLD *SALVIA* SPECIES

There are numerous genera with species adapted to different pollinator groups (birds, bees, and others; e.g., Kay et al., 2005; F. Pérez et al., 2006; Wilson et al., 2006), but a survey of such a large number of species has never been done (426 species of *Erica* L. [Rebelo et al., 1985]; 208 taxa including subspecies or varieties of *Pelargonium* L'Hér. [Struck, 1997]). In the present study our attempt to group all of the 602 New World *Salvia* species according to pollinator groups/pollination syndromes was successful. The great majority (almost 90%) of the species could be identified as having either bird-pollinated or bee-pollinated flowers. Although the correspondence between our grouping and the traditionally distinguished pollination syndromes is high, our approach is empirical. We added some new essential data, not only by asking whether a flower would fit to a certain pollinator, but also by testing which visitors might be excluded from the process of pollen transfer. Consequently, our description of ornithophilous species differs from previously existing ones.

Ornithophily: An update of phenotypic characters and geographic distribution in bird-pollinated sages. According to our grouping, about one third of the New World sages are ornithophilous, showing a high diversity of floral characters. Referring to all *Salvia* species (worldwide), about 20% appear to be bird pollinated. Although many of the sages traditionally seen as bird pollinated correspond to our grouping (e.g., Delpino, 1868–1874; Trelease, 1881, 1882; Gams, 1927; Zalewska, 1928; Himmelbaur & Stibal, 1932, 1933, 1934; Reisfield, 1987; Ramamoorthy & Elliott, 1998; Torke, 2000; Walker & Elisens, 2001), there are also disagreements. *Salvia carduacea*, for instance, was classified as an ornithophilous species by Zalewska (1928; see also Pickens, 1936). Although hummingbirds occasionally visit this species, they might never or only accidentally contact the reproductive organs (Visco & Capon, 1970; Read, 1983). Sometimes a few species of moths and butterflies were noticed at the flowers. However, it is unclear whether they contacted the pollen sacs and stigma, and pollen was never found on their bodies (see also Visco & Capon, 1970; Read, 1983). On the contrary, several species of bees were observed to land on the lower lip of the sweet-scented flowers. While drinking nectar or collecting pollen, the bees often came into contact with the reproductive organs and their bodies were dusted

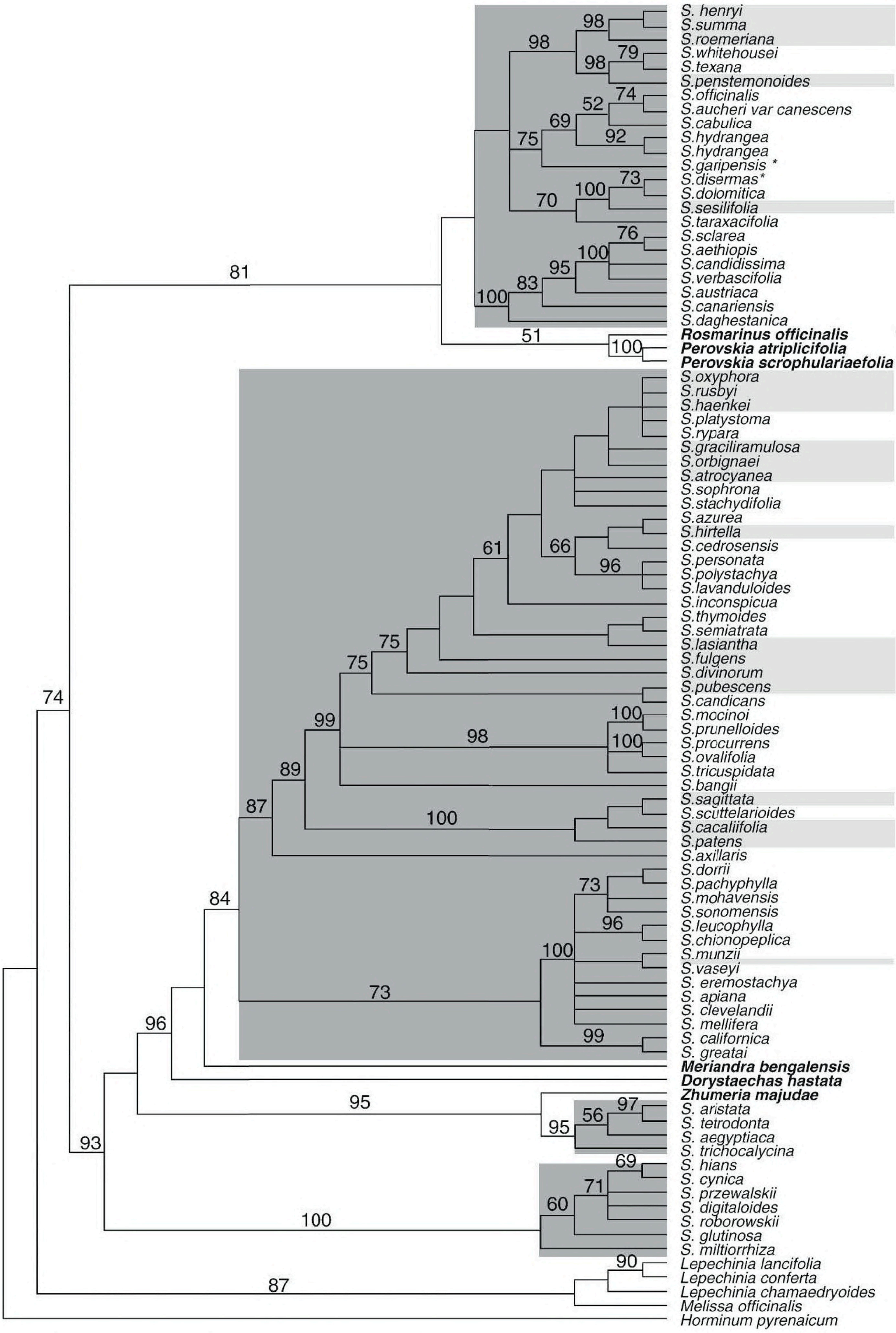

Figure 7. Phylogenetic relationships in *Salvia* s.l. (dark gray) with bird-pollinated species indicated (light gray). The phylogeny is based on Walker and Sytsma (2007). The gray line between *S. munzii* and *S. vaseyi* indicates the position of *S. spathacea* within *Salvia* sect. *Audibertia* (see Walker et al., 2004).

with pollen (Visco & Capon, 1970; Read, 1983; this study). Faegri and van der Pijl (1971) assumed *S. lasiantha* to be myiophilous without giving reasons. Although the species has relatively short corolla tubes, it appears ornithophilous to us, with its usually deflexed or reflexed lower lips and exserted thecae (Wester & Claßen-Bockhoff, 2007). *Salvia cacaliifolia* Benth. was listed as melittophilous by Cruden (1972), but hummingbirds were observed at the flowers while getting dusted with pollen (Wester & Claßen-Bockhoff, 2007; see also Skutch, 1940). The flowers have short lower lips with front margins that are often oriented upward, making landing difficult for insects. It is unlikely that bees are pollinators as they would hardly touch the exposed reproductive organs. Trelease (1882) discussed *S. heerii* Regel as being ornithophilous and psychophilous. According to Trelease, the species' long corolla tube and small lower lip prevent bees from landing on the flowers and from reaching the nectar, while the floral form and the large amount of nectar point to birds as a likely pollinator. He also mentioned a narrow passage beneath the connectives and white nectar guides as being suggestive of psychophily. We do not agree with this because the reduced lower lip does not offer a suitable landing platform for butterflies; we regard the species as typically ornithophilous. We also do not share the opinion of Faegri and van der Pijl (1971: 179) that the flowers in *S. coccinea* are only "semi-ornithophilous" because of their labiate shape. Correspondingly, we disagree with Reisfield (1987: 262, 279), who mentioned many ornithophilous species with bilabiate flowers (e.g., *S. fulgens* Cav. and *S. patens*) as being in a "transition phase" between melittophily and ornithophily. Additionally, contrary to the common view that ornithophilous flowers are characterized by stiff corollas, we also found weaker flowers to be bird pollinated, at least in species with short- to medium-sized flowers. This fits our observations that hummingbirds handle the flowers without damaging them (see also Snow & Snow, 1980). Stiff corollas are not absolutely needed to protect the flowers against visiting birds and robbing birds or bees, as stated by Proctor et al. (1996). Instead, these animals are also able to pierce strengthened corollas (e.g., *S. grewiifolia* S. Moore and *S. leucantha*, Wester & Claßen-Bockhoff, 2007). We conclude that stiff corollas stabilize the flowers rather than protect them from birds.

In addition to corolla shape and stability, corolla color of the ornithophilous sages also differs from what has been suggested by other authors. According to Baumberger (1987), 52% of the ornithophilous angiosperms have multicolored corollas (see also Porsch, 1924; Faegri & van der Pijl, 1971) (including nectar guides), but in sages the corolla is usually unicolored; it only contrasts with the calyx or leaves.

The distribution of ornithophilous New World sages does correspond to that of hummingbirds. In regions with a high number of ornithophilous *Salvia* species, hummingbirds show their highest species number and diversity (Schuchmann, 1999; see also Reisfield, 1987). Furthermore, as do bird-pollinated plants in general, ornithophilous sages appear primarily at higher altitudes (Cruden, 1972; Feinsinger, 1983; Reisfield, 1987; Kay et al., 2005). This corresponds to the equally high abundance of hummingbirds at similar altitudes (Cruden, 1972; Schuchmann, 1999; Altshuler et al., 2004). The interdependence between bird-pollinated flowers and hummingbirds is also supported by a comparison of floral tube lengths (of ornithophilous sages and ornithophilous angiosperms in general) with bill lengths in hummingbirds. For example, both the range of bill lengths and tube lengths in general broadens with lower latitude (Baumberger, 1987; Schuchmann, 1999).

Melittophily: Barriers in flowers as adaptation to bees. While ornithophilous flowers definitely exclude bees, bee-pollinated flowers do not exclude birds. However, birds are more attracted by ornithophilous species because their flowers, for example, produce larger quantities of nectar (see Faegri & van der Pijl, 1971; Stiles, 1981; Rodríguez-Gironés & Santamaría, 2004).

The examined species of the bee-pollinated sages differ from the general picture of bee-pollinated flowers (Vogel, 1954) in nearly lacking a definite petal scent (exceptions in *Salvia* sections *Audibertia* and *Echinosphace*). They share this character with many other Lamiaceae, which instead produce scent in their sepals and vegetative leaves. This scent is assumed to be used for pollination in insect-pollinated species, while a typical melittophilous scent is largely lacking (Mattern & Vogel, 1994).

There are two unusual features related to floral organization worth noting in bee-pollinated species. First, more or less concealed or closed floral entrances due to connivent corolla lips appear in some species (e.g., in *Salvia betonica*, *S. lavanduloides*), resembling those in the tribe Antirrhineae Chav. (Plantaginaceae Juss.), for example. This blocking of the entrance protects pollen and forces the bees to handle the flower with physical force (see Westerkamp & Claßen-Bockhoff, 2007). Also, there is often one additional staminal barrier in the flowers narrowing the entrance. As Claßen-Bockhoff et al.

(2004a) found, this barrier may either be the sterile thecae (*S. uliginosa*) of the two adjacent stamens or a ventral outgrowth of their sterile connective arms (*S. rypara*, Fig. 6D), illustrating that different morphological structures result in the same functional constructions in the flower. Besides blocking the flower entrance, the large barrier contributes to the release of the lever mechanism as the bees encounter this barrier in their search for nectar (see also Reisfield, 1987). As the majority of the New World *Salvia* species belong to subgenus *Calosphace*, they have straight posterior lever arms that reach far behind the flower entrance. By producing ventral protrusions, a lever apparatus results that parallels the form of the curved levers, typical for many bee-pollinated species from the Old World (see also Hildebrand, 1865; Ogle, 1869; Correns, 1891; Himmelbaur & Stibal, 1932, 1933, 1934). Perhaps bee-pollinated flowers need such a barrier to enable the bees to release the lever mechanism. In contrast, such an auxiliary construction is not needed in bird-pollinated flowers as birds are able to touch each kind of abutment with their long bills.

Indications of psychophily in Salvia. The genus *Salvia* encompasses only a few species assumed to be psychophilous, e.g., *S. scabra* L. f. in South Africa (long-tongued flies assumed by Potgieter & Edwards, 2001) or *S. nanchuanensis* Y. Z. Sun in China (Wester, unpublished). Until now, no observations of flower-pollinator interactions exist in these species. This is also true for *S. whitehousei* (Fig. 6J), which we assume to be a further psychophilous species in the New World, with butterflies or psychoid insects (long-tongued flies) as pollinators. This species is only known from Texas and Coahuila (Mexico) and is little known. The upper lip does not have the typical hooded or galeate shape of most of the sages including other representatives of *Salvia* sect. *Salviastrum* (e.g., *S. texana*, Fig. 6B, C) and most of the *Salvia* species in subgenus *Calosphace*, and as incorrectly illustrated in the only published description by Whitehouse (1949). Instead, the lips of *S. whitehousei* spread at a right angle to the long tube and thus the flower forms a Stielteller flower sensu Vogel (1954), being characteristic for psychophilous flowers.

Intermediates or not clearly assignable species. We found "intermediate flowers" not clearly belonging to a specific pollination syndrome. They could not be grouped because of fragmentary or conflicting descriptions or because they share characters of several syndromes (for instance, bee-pollinated and bird-pollinated flowers). Because of evolutionary transitions, we expect that not all species can be classified into pollination syndromes. They illustrate natural variation and should not be taken as an argument against the validity of pollination syndromes.

One species that provides an example of conflicting or missing data is *Salvia purpurea*, which is highly variable in color, size, and proportions. Dependent on the locality and time of observation, either hummingbirds, butterflies, or bees are reported to be more abundant (C. González, M. Ordano & A. Luis-Martínez, pers. comm.). Different visitor groups were also found in *S. clevelandii*, which is reported to be often visited and pollinated by hummingbirds and also by small hawkmoths (Cox, 1981; B. O'Brien, pers. comm.). The yellow flowers of *S. aspera* are mentioned to be pollinated by bees (Ramamoorthy & Elliott, 1998), but it is possible that this conclusion refers to the yellow color taken as a typical melittophilous trait. Instead, bird-pollinated species also have yellow flowers.

Difficulties are also caused by taxonomic conflicts. Some taxa may be recognized as synonyms or some species may include highly variable subspecies or varieties (*Salvia arenaria* A. St.-Hil. ex Benth., *S. amethystina* Sm., *S. carnea* Kunth, *S. mexicana*; see also Appendix 3). *Salvia carnea*, for instance, includes formerly separate species that vary in flower size and color. The morphs range from ornithophilous (*S. carnea* var. *punicans* (Epling) J. R. I. Wood & Harley) to melittophilous (sensu *S. gracilis* Benth.), forming a continuum with other taxa like a "ring of races" (Reisfield, 1987: 278). The appearance of different morphs within a species complicates their grouping. *Salvia mohavensis*, for instance, is distributed in the southwestern United States and northern Mexico (Neisess, 1983; A. Sanders, pers. comm.). The widespread "normal" light blue Stielteller flowers combine ornithophilous and psychophilous characters and are observed to be visited by hummingbirds and long-tongued flies (Fenster et al., 2004; B. O'Brien & P. Wilson, pers. comm.), with the latter classified as psychoid insects. Individuals of *S. mohavensis* in northern Mexico, isolated by 300 km, have flowers with a rather ornithophilous form (broader corolla tube, lip orientation, color) and are reported to be visited by hummingbirds (A. Sanders, pers. comm.). If gene flow is disrupted between these different morphs, subspecies or even new species may evolve (cf. Johnson, 1997).

Morphological intermediates sharing characters of two or three pollination syndromes can be interpreted in different ways. One interpretation is that the classification is inappropriately narrow and excludes less typical representatives from a syndrome. Another possible interpretation is that the intermediates represent momentary transitional stages from one syndrome to the other, following a strong unidirectional selection pressure (see also Reisfield, 1987; for other genera, see, e.g., Baker, 1963; Stebbins, 1974; Macior, 1986; Sazima et al., 1994; Manning & Goldblatt, 2005; Wilson et al., 2006). These intermediates might be attractive for different groups at the same time, for example, for bees (e.g., landing platform, short corolla tube) and birds (e.g., a larger volume of nectar) (e.g., F. Pérez et al., 2006; Wilson et al., 2006; see also Hardy, 1954; Thomson et al., 2000; Thomson, 2003).

Given the assumed shift between different pollinator groups and ecologic constraints, intermediate stages among clearly adapted flowers should be expected. This is especially true for the young and evolutionarily unstable *Salvia* subg. *Calosphace* and *Salvia* sect. *Audibertia*, which include many endemics and highly variable species (*Salvia* subg. *Calosphace*, Reisfield, 1987) and hybrids (especially section *Audibertia*; Emboden, 1971; Neisess, 1983). However, the limited number of intermediate flowers in *Salvia* indicates a strong selection pressure against the presence of more than one dominant pollinator group.

PARALLEL EVOLUTION OF POLLINATION SYNDROMES IN THE GENUS *SALVIA*

Because bee-pollinated and bird-pollinated flowers are found in different lineages in the Old and New World and differ in their floral morphologies, their parallel evolution is obvious (see also Himmelbaur & Stibal, 1932, 1933, 1934; Grant & Grant, 1965; Baumberger, 1987; Reisfield, 1987; Wester & Claßen-Bockhoff, 2006b, 2007). This has also been confirmed by the phylogenetic studies of Walker and Sytsma (2007). Referring our results to their phylogenetic tree (Fig. 7; Walker & Sytsma, 2007: 383), ornithophilous species appear in two of their three clades. Following parsimony in their clade I (Walker & Sytsma, 2007), the New World taxa (*Salvia* sect. *Heterosphace*, *Salvia* sect. *Salviastrum*, and *S. pentstemonoides*) show two parallel shifts from melittophily to ornithophily and one from melittophily to psychophily (see also Walker et al., 2004: 1118). A further shift from melittophily to ornithophily in clade I is found for the Madagascan *S. sessilifolia* Baker (see also Wester & Claßen-Bockhoff, 2006b). In their clade II, shifts from melittophily to ornithophily happened at least twice in the New World *Salvia* subg. *Calosphace* and at least once in the New World *Salvia* sect. *Audibertia* (for *S. spathacea*, see Walker et al., 2004). *Salvia* thus corresponds to genera such as *Aquilegia* L., *Costus* L., *Mimulus* L., and *Penstemon* Schmidel (Beardsley et al., 2003; Castellanos et al., 2004; Kay et al., 2005; Wilson et al., 2006; Whittall & Hodges, 2007), in which similar repeated shifts from entomophilous to ornithophilous species have been documented. In view of the many species in *Salvia*, with the ongoing phylogenetic research in New World species (Dos Santos, pers. comm.; Jenks, pers. comm.; Walker, pers., comm.) and hopefully more extended field studies, the genus could represent an adequate model system to investigate the evolution of ornithophily in more depth.

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APPENDIX 1. List of sources used for the 602 *Salvia* species. Sources are listed in this order: the literature, herbarium specimens, plants studied in the field (wild), and in cultivation (cult.); square brackets indicate that only pickled flowers were available. Asterisks follow type specimens.

S. acerifolia B. L. Turner: Turner, 2008a; *Cowan 5646** (TEX-LL). ***S. acuminata*** Ruiz & Pav.: Ruiz & Pavon, 1798; Epling, 1939; *Macbride 3661* (F); *Weberbauer 6699* (GH). ***S. adenophora*** Fernald: Epling, 1939; dos Santos, 1991; *M. Crone 7* (MJG, cult.); *Nelson 2093**, *2093a** (US). ***S. aequidistans*** Fernald: Epling, 1939; *Rose 1609** (NY). ***S. agnes*** Epling: Epling, 1939; *Mexia 1582a** (C, NY). ***S. alamosana*** Rose: Epling, 1939; *Palmer 345** (US). ***S. alariformis*** L. O. Williams: Standley & Williams, 1973; *Williams & Molina 11459** (GH). ***S. alata*** Epling: Epling, 1960; Epling & Játiva, 1963; *Angulo 1684** (HUT, UC-JEPS); *Sagástegui 7691* (GH). ***S. alba*** J. R. I. Wood: Wood, 2007. ***S. albiflora*** M. Martens & Galeotti: Standley & Williams, 1973; Dieringer et al., 1991; Pool, 2001. ***S. albocaerulea*** Linden: Epling, 1939; *Ramos Marchena s.n.* (B). ***S. alborosea*** Epling & Játiva: Epling & Játiva, 1966; Sagástegui et al., 2003; *Hart 1533* (K); *Lezama & Veneros 15557* (K); *Llatas Quiroz 2141* (F); *López et al. 3724** (UC-JEPS); *Sagástegui 15910* (TEX-LL). ***S. aliciae*** E. P. Santos: dos Santos, 1993; *S. Vogel 1965/613* (WU). ***S. altimitrata*** Epling: Epling, 1939; *Goldman 823** (US). ***S. altissima*** Pohl: Epling & Toledo, 1943; *Pohl 1718* (K). ***S. alvajaca*** Oerst.: Standley & Williams, 1973; Pool, 2001; *Allen 1355** (MO, US). ***S. amarissima*** Ortega: Epling, 1939. ***S. amethystina*** Sm.: Epling, 1939, 1941; Wood & Harley, 1989; Fernández Alonso, 1995a; *Fernández Alonso et al. 11688** (COL); *Haught 6192** (US); *Humboldt & Bonpland s.n.** (P); *Wood 5031** (COL). ***S. amissa*** Epling: Epling, 1939; *Pringle 1001** (NY). ***S. ampelophylla*** Epling: Epling, 1939; Reisfield, 1987; Wood & Harley, 1989; Fernández Alonso, 2003; see also Appendix 3. ***S. amplifrons*** Briq.: Epling, 1939; Wood, 2007; *S. Vogel 1965/500* (WU); *P. Wester 141* (LPB, MJG, wild, cult.). ***S. anastomosans*** Ramamoorthy: Ramamoorthy, 1984c; Dieringer et al., 1991. ***S. anguicoma*** Epling: Epling, 1947; *Steyermark 55830** (UC-JEPS). ***S. angulata*** Benth.: Epling, 1939; *Smith 1370** (NY, TEX-LL). ***S. angustiarum*** Epling: Fernald, 1900; Epling, 1939; Reisfield, 1987; *Palmer 184** (GH, MO, NY, P, US); *Pringle 9377* (B). ***S. apiana*** Jeps.: Pickens, 1929; Epling, 1938; Grant & Grant, 1964; Neisess, 1983; Reisfield, 1987; *P. Wester 396*, *410*, *455* (MJG, wild), *411* (MJG, UCR, wild), *597* (MJG, cult.). ***S. apparicii*** Brade & Barb. Per.: Brade & Barbosa, 1946. ***S. aratocensis*** (J. R. I. Wood & Harley) Fern. Alonso: Wood & Harley, 1989; Fernández-Alonso, 2003; see also Appendix 3; *Wood 5052** (COL). ***S. arborescens*** Urb. & Ekman: Epling, 1939; Liogier, 1994. ***S. arbuscula*** Fernald: Epling, 1939; *Langlassé 767** (G, GH, K, P). ***S. arduinervis*** Urb. & Ekman: Torke, 2000; *Ekman H-3168/b** (GH, K, NY). ***S. arenaria*** A. St.-Hil. ex Benth.: Epling, 1939; Epling & Toledo, 1943; Epling & Mathias, 1957; Sazima et al., 1996; Buzato et al., 2000; *Dusén s.n.* (US); *Irwin 2780* (NY); *S. Vogel 1965/751*, *1965/688* (WU). ***S. areolata*** Epling: Epling, 1944, 1947; *Steyermark 50338** (UC-JEPS). ***S. aridicola*** Briq.: Epling, 1939; dos Santos, 1996; *Hassler 5227** (NY). ***S. arizonica*** A. Gray: Epling, 1939. ***S. arthrocoma*** Fernald: Epling, 1939; *Pringle 8940** (L). ***S. articulata*** Epling: Epling, 1939; Epling & Toledo, 1943; dos Santos, 1991; *W. Hoehne s.n.* (K); *Mosén 1922** (S); *Krapovickas & Cristóbal 35441* (K); *Regnell I 312* (K); *S. Vogel 1965/784* (WU). ***S. aspera*** M. Martens & Galeotti: Epling, 1939; *Pringle 6240* (P); *P. Wester 257* (MEXU, MJG, wild), *261* (MJG, wild), *546* (MJG, cult.). ***S. assurgens*** Kunth: Epling, 1939; *Humboldt & Bonpland s.n.** (P); *Pringle 4150* (F). ***S. atrocalyx*** Epling: Epling, 1939; *Killip 24401** (F, GH, NY, US). ***S. atrocaulis*** Fernald: Epling, 1939; *Pringle 8887** (C, GH, K, P, S, US). ***S. atrocyanea*** Epling: Epling, 1939; Legname, 1962; Pontiroli, 1993; Wester & Claßen-Bockhoff, 2007; Wood, 2007; *P. Wester 3* (K, LPB, MJG, wild), *5–7* (MJG, wild), *8* (MJG, wild, cult.). ***S. atropaenulata*** Epling: Epling, 1939, 1940a; *Mexia 9056** (B, GH, MO, NY, US). ***S. austromelissodora*** Epling & Játiva: Epling & Játiva, 1966. ***S. axillaris*** Moç. & Sessé ex Benth.: Epling, 1939; Reisfield, 1987; Turner, 1996c; Ramamoorthy, 2001; *García 1168** (TEX-LL), *Pringle 6905* (MEXU); *P. Wester 269* (MJG, wild). ***S. axilliflora*** Epling: Epling, 1939; Steyermark & Huber, 1978; *Eggers 13414** (C). ***S. ayavacensis*** Kunth: Kunth, 1817; Epling, 1937, 1939; Macbride, 1960; *Weberbauer 6399** (F, GH). ***S. azurea*** Michx. ex Lam.: Epling, 1939; Peterson, 1978; *Lindheimer 145** (NY).

S. bahorucona Urb. & Ekman: Torke, 2000. ***S. balaustina*** Pohl: Epling, 1939; dos Santos, 1991; Buzato et al., 2000; *Buzato & Sazima 26.293* (K). ***S. ballotiflora*** Benth.: Epling, 1939; *Palmer 717* (P); *Wright 1524* (NY). ***S. benthamiana*** Gardner: Epling, 1939; dos Santos, 1991; *Gardner 580** (G, K, NY, UC-JEPS, US). ***S. betonica*** Schult.: Epling, 1939; *M. Crone 23* (MJG); *P. Wester [184]* (MJG, wild); *Humboldt s.n.* (B). ***S. betulifolia*** Epling: Epling, 1941; Ahlenslager, 1984; Van Devender et al., 2004; *Palmer 477** (MO, NY); *Reveal 3037** (MO, NY, TEX-LL, US). ***S. biserrata*** M. Martens & Galeotti: Fernald, 1900; Epling, 1939; Reisfield, 1987; *Galeotti 684** (P). ***S. blepharophylla*** Brandegee ex Epling: Epling, 1939; *Purpus 4950** (UC-JEPS), *5450** (MO, NY, US); *P. Wester 450* (MJG, cult.). ***S. boegei*** Ramamoorthy: Ramamoorthy, 1984c. ***S. bogotensis*** Benth.: Epling, 1939. ***S. booleana*** B. L. Turner: Turner, 1995c; *Lundell 5470* (TEX-LL). ***S. borjensis*** E. P. Santos: dos Santos, 1995, 1996. ***S. brachyloba*** Urb.: Epling, 1939; Liogier, 1994; *Ekman 9317* (K). ***S. brachyodonta*** Briq.: Epling, 1939; *Pringle 2463** (NA, NY, P). ***S. brachyphylla*** Urb.: Epling, 1939; Liogier, 1994; *Ekman 8252* (K). ***S. brandegeei*** Munz: Epling, 1938, 1940c; Neisess, 1983; *P. Wester 514*, *596* (MJG, cult.). ***S. breviflora*** Moç. & Sessé ex Benth.: Epling, 1939; Dieringer et al., 1991; *Pringle 8430** (P). ***S. brevipes*** Benth.: Epling, 1939; Crespo, 1979; dos Santos, 1996. ***S. buchananii*** Hedge: Hedge, 1963; *P. Wester 545* (MJG, cult.). ***S. buchii*** Urb.: Epling, 1939; Liogier, 1994; *Buch 658** (GH). ***S. bullulata*** Benth.: Epling, 1939; *Donnell Smith 765* (US); *Matthews 1862* (US).

S. caaguazuensis Briq.: Epling, 1939; dos Santos, 1996; *Hassler 4280** (NY). ***S. cabonii*** Urb.: Epling, 1939; Liogier, 1994. ***S. cacaliifolia*** Benth.: Epling, 1939; Skutch, 1940; Wester & Claßen-Bockhoff, 2007; *P. Wester 416*, *558* (MJG, cult.). ***S. calaminthifolia*** Vahl: Epling, 1939; Liogier, 1994. ***S. calcicola*** Harley: Harley, 1974; *Irwin 12026** (NY). ***S. californica*** Brandegee: Epling, 1938; Shreve & Wiggins, 1964; Neisess, 1983; *P. Wester 470*, *486* (MJG, cult.). ***S. calolophos*** Epling: Epling, 1939; *S. Vogel 1970/582* (WU). ***S. camarifolia*** Benth.: Epling, 1939; Wood & Harley, 1989; Fernández Alonso, 2002; *Smith 379* (K), *567** (GH, H, K, NY, P, TEX-LL, UC-JEPS); *Fernández Alonso et al. 13352**, *13785** (COL). ***S. campicola*** Briq.: Epling, 1939; dos Santos, 1996. ***S. camporum*** Epling: Epling, 1944; *Metcalf 30805** (GH). ***S. candicans*** M. Martens & Galeotti: Epling, 1939; *Pringle 6245* (P). ***S. capillosa*** Epling: Epling, 1940a, 1941; *Hinton 13020** (NY). ***S. carbonoi*** Fern. Alonso: Fernández-Alonso, 2003; *Kirkbride 2001** (COL). ***S. cardenasii*** J. R. I. Wood: Wood, 2007. ***S. cardiophylla*** Benth.: Crespo, 1979; dos Santos, 1996. ***S. carduacea*** Benth.: Epling, 1938; Visco & Capon, 1970; Read, 1983; *P. Wester 395* (MJG, wild). ***S. carnea*** Kunth: Fernald, 1900; Epling, 1939, 1940a; Standley & Williams, 1973; Wolf et al., 1976; Reisfield, 1987; Wood & Harley, 1989; Dieringer et al., 1991; Farji Brener, 1991; Ramamoorthy, 2001; *Hinton 11224** (NY, TEX-LL, US); *Humboldt & Bonpland s.n.** (P); *Pringle 8927** (L, NY, P, US); *Skutch 1971** (NY). ***S. caudata*** Epling: Epling, 1939; *Mueller 143** (GH). ***S. caymanensis*** Millsp. & Uline ex Millsp.: Epling, 1939. ***S. cedrosensis*** Greene: Epling, 1939. ***S. cerradicola*** E. P. Santos: dos Santos, 1993, 1996. ***S. chalarothyrsa*** Fernald: Epling, 1939; *Pringle 8856** (L, NY, P). ***S. chamaedryoides*** Cav.: Epling, 1939; *Pringle 6907* (P). ***S. chapadensis*** E. P. Santos & Harley: dos Santos & Harley, 2004. ***S. chapalensis*** Briq.: Epling, 1939; *Pringle 4351** (C, L, NY, TEX-LL). ***S. chazaroana*** B. L. Turner: Turner, 2009b. ***S. chiapensis*** Fernald: Epling, 1939; Cruden, 1972; *Gomez Lopez 179* (MEXU); *Nelson 3201** (US); *P. Wester 427* (MJG, cult.). ***S. chicamochae*** J. R. I. Wood & Harley: Wood & Harley, 1989; Fernández Alonso, 2003; *Wood 5134** (COL). ***S. chionopeplica*** Epling: Epling, 1940c; Shreve & Wiggins, 1964; Neisess, 1983; *Palmer 368** (NY); *Raven 125551** (K); *Reid Moran 20590* (SD); *P. Wester 467*, *485* (MJG, cult.); *Wiggins 5300** (GH, NY). ***S. chionophylla*** Fernald: Epling, 1939. ***S. cinnabarina*** M. Martens & Galeotti: Epling, 1939; Skutch, 1940; Standley & Williams, 1973; Dieringer et al., 1991; Schondube et al., 2004; Wester & Claßen-Bockhoff, 2007; *Pringle 4947** (P); *P. Wester 198*, *283*, *290*, *302* (MJG, wild), *265* (MEXU, MJG, wild). ***S. clarendonensis*** Britton: Epling, 1939; *Harris 12787** (NY). ***S. clarkcowanii*** B. L. Turner: Dieringer et al., 1991; Turner, 2008b; *Calzada 20723*, *21621* (MEXU), *Cowan 4941* (MEXU), *Torres 10810* (MEXU); *Martínez et al. 6191* (MEXU, RSA). ***S. clevelandii*** (A. Gray) Greene: Cox, 1981; Neisess, 1983; *P. Wester 515* (MJG, wild), [*406*], *487*, *560* (MJG, cult.). ***S. clinopodioides*** Kunth: Epling, 1939; Martínez & Matuda, 1984; *Humboldt & Bonpland s.n.** (P). ***S. coahuilensis*** Fernald: Epling, 1939; *Palmer 194** (NY). ***S. coccinea*** Buc'hoz ex Etl.: Epling, 1939; Grases & Ramírez, 1998; Ortiz-Pulido et al., 2002; *P. Wester 12* (LPB, MJG, wild), *237* (MEXU, MJG, wild), *299* (MJG, wild), *556* (MJG, cult.). ***S. cocuyana*** Fern. Alonso: Fernández Alonso, 1995a; *Wood 5139** (COL). ***S. codazziana*** Fern. Alonso: Fernández Alonso, 1995c; *Rangel 12336** (COL). ***S. cognata*** Urb. & Ekman: Epling, 1939; Liogier, 1994; *Ekman 5048** (GH, K, S, US). ***S. collinsii*** Donn. Sm.: Epling, 1939. ***S. colonica*** Standl. & L. O. Williams ex Klitg.: Klitgaard, 2007. ***S. columbariae*** Benth.: Epling, 1938; Visco & Capon, 1970; Neisess, 1983; Reisfield, 1987; *P. Wester 394*, *407* (MJG, wild). ***S. comayaguana*** Standl.: Epling, 1939; Pool, 2001; *Standley 55843** (US). ***S. compsostachys*** Epling: Epling, 1940a. ***S. concolor*** Lamb. ex Benth.: Epling, 1939; Ramamoorthy, 2001; *Beaman 2068* (MEXU); *P. Wester 167* (MEXU, MJG, wild, cult.). ***S. confertiflora*** Pohl: Epling, 1939; dos Santos, 2004; *P. Wester 561* (MJG, cult.). ***S. congestifolia*** Epling: Epling, 1939; Epling & Toledo, 1943. ***S. connivens*** Epling: Epling, 1939; *Pringle 3224** (P, TEX-LL). ***S. consimilis*** Epling: Epling, 1939; Epling & Toledo, 1943. ***S. consobrina*** Epling: Epling, 1960; *López 2281** (HUT, UC-JEPS); *Weberbauer 7654* (F). ***S. cordata*** Benth.: Epling, 1939; dos Santos, 1996. ***S. corrugata*** Vahl: Epling, 1939, 1941; Wood & Harley, 1989; *Hutchinson 6575* (F); *P. Wester* [*590*] (MJG, cult.). ***S. costaricensis*** Oerst.: Epling, 1939; Hedström, 1985. ***S. costata*** Epling: Epling, 1939; Wood & Harley, 1989. ***S. coulteri*** Fernald: Epling, 1939; *Coulter 1120** (K, NY). ***S. crucis*** Epling: Epling, 1939. ***S. cruckshanksii*** Benth.: Epling, 1939; *Matthews 464** (L); *Penell 14332* (F). ***S. cryptodonta*** Fernald: Epling, 1939. ***S. cuatrecasana*** Epling: Epling, 1944; Wood & Harley, 1989; Fernández Alonso, 2003; *Cuatrecasas 10407** (COL). ***S. cubensis*** Britton & P. Wilson: Epling, 1939; S. Vogel, pers. comm.; *Howard 6170* (P); *Shafer 3766** (NY). ***S. curta*** Epling: Epling, 1939; Epling & Toledo, 1943; *Dusén 1283** (NY). ***S. curticalyx*** Epling: Epling, 1940a; *Penland & Summers 1191** (GH). ***S. curtiflora*** Epling: Epling, 1939; *Skutch 1972** (NY, US); *P. Wester 294* (MEXU, MJG, wild); *Williams et al. 23188* (TEX-LL). ***S. curviflora*** Benth.: Epling, 1939; *Graham 97** (K). ***S. cuspidata*** Ruiz & Pav.: Epling, 1939; Wood, 2007; *P. Wester 9*, *11*, *13* (LPB, MJG, wild). ***S. cyanantha*** Epling: Epling, 1940a; *Hinton 15350** (GH, NY, UC-JEPS, US); *Mexia 8729** (S). ***S. cyanicalyx*** Epling: Epling, 1941; *Schmidt-Lebuhn 578* (K, MJG, cult.); *Stork et al. 10618** (F). ***S. cyanocephala*** Epling: Epling, 1939; Wood & Harley, 1989; Fernández Alonso, 2003, 2006; *Wood 5000* (MEXU), *5409*, *5122* (K); *Fernández Alonso et al. 14605* (MEXU); *Fernández Alonso & Castillo 18917** (COL). ***S. cyanotropha*** Epling: Epling, 1939. ***S. cylindriflora*** Epling: Epling, 1939; *Pearce 565** (K).

S. darcyi J. Compton: Compton, 1994; *P. Wester 479*, *566* (MJG, cult.). ***S. dasycalyx*** Fernald: Epling, 1939. ***S. decumbens*** Alain: Liogier, 1973, 1994; *Liogier 17932** (NY). ***S. decurrens*** Epling: Epling, 1939; Epling & Toledo, 1943. ***S. densiflora*** Benth.: Epling, 1939; *Ekman 13924* (K). ***S. diamantina*** E. P. Santos & Harley: dos Santos & Harley, 2004. ***S. dichlamys*** Epling: Epling, 1939, 1940a; Epling & Játiva, 1966; Martínez & Matuda, 1984; *Hinton 914** (K, NY), *13956** (NY, TEX-LL, UC-JEPS, US). ***S. discolor*** Kunth: Epling, 1939; *Weberbauer 6069* (F); *P. Wester 574* (MJG, cult.). ***S. disjuncta*** Fernald: Epling, 1939; Standley & Williams, 1973; dos Santos, 1991; *Ghiesbreght 76** (NY), *753* (MO); *Nelson 3166* (US); *P. Wester 254* (MEXU, MJG, wild, cult.), *296*, *304* (BIGU, MEXU, MJG, wild). ***S. divinorum*** Epling & Játiva: Epling & Játiva, 1962; Reisfield, 1993; *Reisfield 1242* (K); *P. Wester 575* (MJG, cult.). ***S. dombeyi*** Epling: Mulsant & Verreaux, 1876; Epling, 1939; Macbride, 1960; Wood, 2007; *S. King 278* (F); *Mandon 712* (K); *Pearce 851* (K); *P. Wester* [*576–577*] (MJG, cult.). ***S. dorisiana*** Standl.: Standley, 1950; *P. Wester 578* (MJG, cult.); *Williams & Molina 13667** (US). ***S. dorrii*** (Kellogg) Abrams: Kellogg, 1863; Epling, 1938; Visco & Capon, 1970; Strachan, 1982; Neisess, 1983; Reisfield, 1987; *P. Wester 392*, *512*, *522*, *523* (MJG, wild), *600* (MJG, cult.). ***S. drymocharis*** Epling: Epling, 1939. ***S. dryophila*** Epling: Epling, 1939; *Hinton 5406** (NY). ***S. dugesiana*** Epling: Epling, 1939; *Dugès 226** (GH). ***S. durantiflora*** Epling: Epling, 1939; *Mexia 8944* (B). ***S. durifolia*** Epling: Epling, 1939; dos Santos, 1996. ***S. duripes*** Epling & Mathias: Epling & Mathias, 1957; *Matuda 5810**, *6010* (TEX-LL).

S. ecuadorensis Briq.: Epling, 1939; *Spruce 5543** (C, GH, GOET). ***S. eizi-matudae*** Ramamoorthy: Epling, 1939; Ramamoorthy, 1987; *Matuda 138** (UC-JEPS, US). ***S. elegans*** Vahl: Epling, 1939; Wagner, 1946; Dieringer et al., 1991; Van Devender et al., 2004; Lara, 2006; *Galeotti 685** (P); *P. Wester 156*, *193*, *214* (MJG, wild), *165* (MEXU, MJG, wild), *579* (MJG, cult.). ***S. emaciata*** Epling: Epling, 1939. ***S. engelmannii*** A. Gray: Whitehouse, 1949; *McVaugh 8297* (P); *P. Wester* [*360*] (MJG, cult.). ***S. eplingiana*** Alziar: Epling, 1949a; Alziar, 1988a; *Hinton 11260** (NY, TEX-LL). ***S. eremostachya*** Jeps.: Epling, 1938; Shreve & Wiggins, 1964; Neisess, 1983; *P. Wester 459* (MJG, wild, cult.), *460* (MJG, wild). ***S. eriocalyx*** Bertero ex Roem. & Schult.: Epling, 1939. ***S. ernesti-vargasii*** C. Nelson: Nelson, 1984; *Nelson 3678** (MO). ***S. erythrostephana*** Epling: Epling, 1951; Epling & Mathias, 1957; *Tucker 989* (K). ***S. erythrostoma*** Epling: Epling, 1939; Wood & Harley, 1989; Fernández Alonso, 1995c; *Fernández*

*Alonso 11913** (COL); *Killip 16772** (NY). ***S. espirito-santensis*** Brade & Barb. Per.: Brade & Barbosa, 1946; dos Santos, 1991; *Brade et al. 18369** (K). ***S. exilis*** Epling: Epling, 1940a; *Mexia 9097** (B, NY, TEX-LL). ***S. expansa*** Epling: Epling, 1951. ***S. exserta*** Griseb.: Epling, 1939, 1941; Wester & Claßen-Bockhoff, 2007; Wood, 2007; *Krapovickas 19167* (P); *Lorentz & Hieronymus 985** (UC-JEPS: slide with flower and copy of GOET); *P. Wester 22*, [*24*], *28* (MJG, wild), *27* (MJG, wild, cult.), *23* (LPB, MJG, wild, cult.).

S. falcata J. R. I. Wood & Harley: Wood & Harley, 1989; *Wood 4944* (K), *Wood 4962** (COL, K). ***S. fallax*** Fernald: Epling, 1939, 1941; *Palmer 1964** (C, NY, P). ***S. farinacea*** Benth.: Epling, 1939; *P. Wester 349* (MJG, wild). ***S. fernaldii*** Standl.: Epling, 1939. ***S. festiva*** Epling: Epling, 1939. ***S. filifolia*** Ramamoorthy: Ramamoorthy, 1983a. ***S. filipes*** Benth.: Epling, 1939; *Hartweg 375** (NY, P); *Hinton 9762** (TEX-LL). ***S. firma*** Fernald: Epling, 1939; *Palmer 61** (NY); *Pringle 8757* (P). ***S. flaccida*** Fernald: Epling, 1939; *Nelson 3374* (US); *von Türckheim 780** (GH, P, US). ***S. flaccidifolia*** Fernald: Epling, 1939, 1941; Reisfield, 1987; *Pringle 10298** (C, L, MO, NY, P, TEX-LL, US). ***S. flocculosa*** Benth.: Epling, 1939; *Hartweg 1347** (F). ***S. florida*** Benth.: Epling, 1939, 1941; *Schmidt-Lebuhn 450* (K, MJG, cult.); *Wasshausen 949* (K). ***S. fluviatilis*** Fernald: Epling, 1939; Dieringer et al., 1991; *Pringle 6850** (P). ***S. formosa*** L'Hér.: Ruiz & Pavon, 1798; Mirbel, 1810; Epling, 1939; *Mathews 799* (K); *Sandeman 5/34* (K); *Stork & Horton 9387* (K); *Woytkowski 34003* (F). ***S. forreri*** Greene: Epling, 1939; *Pringle 10104* (P). ***S. foveolata*** Urb. & Ekman: Torke, 2000; *Ekman H7737a, H7799* (K); *Torke 84* (FLAS). ***S. fracta*** L. O. Williams: Standley & Williams, 1973. ***S. fruticetorum*** Benth.: Schmidt, 1858; Epling, 1939; Epling & Toledo, 1943; *Prinz Maximilian zu Neuwied s.n.* (K). ***S. fruticulosa*** Benth.: Epling, 1939; *Andrieux 151** (P). ***S. fulgens*** Cav.: Epling, 1939; Wagner, 1946; Ramamoorthy, 1984a, 2001; Reisfield, 1987; dos Santos, 1991; Wester & Claßen-Bockhoff, 2007; *M. Crone 15* (MJG); *P. Wester 159* (MEXU, MJG, wild, cult.), [*181*] (MJG, wild). ***S. funckii*** Briq.: Epling, 1939; Wood & Harley, 1989; *Funck 280** (G). ***S. funerea*** M. E. Jones: Epling, 1938; Neisess, 1983; *P. Wester 490* (MJG, wild). ***S. fusca*** Epling: Epling, 1939; *Langlassé 216** (P). ***S. fuscomanicata*** Fern. Alonso: Fernández Alonso, 2003; *Sarria 475** (COL).

S. gachantivana Fern. Alonso: Fernández Alonso, 1995a; *Fernández Alonso 8217* (COL); *Wood 5153* (COL). ***S. galloana*** B. L. Turner: Turner, 2009b; *Martínez & Barrie 5678** (TEX-LL). ***S. gesneriiflora*** Lindl. & Paxton: Johow, 1901; Epling, 1939; dos Santos, 1991; Ramamoorthy, 2001; Schondube et al., 2004; *P. Wester 164, 194* (MEXU, MJG, wild), *213* (MJG, wild), *591* (MJG, cult.). ***S. glabra*** M. Martens & Galeotti: Epling, 1939. ***S. glechomifolia*** Kunth: Epling, 1939. ***S. goldmanii*** Fernald: Epling, 1939. ***S. gracilipes*** Epling: Epling, 1951; Wood & Harley, 1989. ***S. graciliramulosa*** Epling & Játiva: Epling & Játiva, 1966; Wood, 2007; *P. Wester 14* (LPB, MJG, wild, cult.). ***S. grandis*** Epling: Epling, 1944; Standley & Williams, 1973; *Steyermark 43047** (UC-JEPS). ***S. gravida*** Epling: Epling, 1940a, 1941; Wester & Claßen-Bockhoff, 2007; *Hinton 12355** (MO, NY, TEX-LL); *Santana & Benz 6602* (ZEA); *P. Wester 196* (MJG, wild, cult.). ***S. greatae*** Brandegee: Epling, 1938; Shreve & Wiggins, 1964; Neisess, 1983; Ross, 1991; *P. Wester 499* (MJG, UCR, wild), *481, 482* (MJG, cult.). ***S. greggii*** A. Gray: Epling, 1939; Wester & Claßen-Bockhoff, 2007; *P. Wester 527* cultivar *alba* (MJG, cult.). ***S. grewiifolia*** S. Moore: Epling & Toledo, 1943; Wester & Claßen-Bockhoff, 2007; Wood, 2007; *P. Wester 15* (K, LPB, MJG, wild, cult.). ***S. grisea*** Epling & Mathias: Epling & Mathias, 1957; *Ferreyra 7628** (F). ***S. griseifolia*** Epling: Epling, 1939. ***S. guadalajarensis*** Briq.: Epling, 1939; *Pringle 4624** (NY, TEX-LL); ***S. guaranitica*** A. St.-Hil. ex Benth.: Epling, 1939; Suarez, 1965; Wester & Claßen-Bockhoff, 2007; *P. Wester 418, 559* (MJG, cult.). ***S. gypsophila*** B. L. Turner: Turner, 2008c, 2008d; *Reveal & Atwood 3421** (TEX-LL).

S. haenkei Benth.: Epling, 1939; Wester & Claßen-Bockhoff, 2006a; Wood, 2007; *P. Wester 55, 56, 58, 61, 67, 74, 80–82, 88* (MJG, wild, div. cult.), *65* (K, LPB, MJG, wild). ***S. haitiensis*** Urb.: Epling, 1939; Liogier, 1994. ***S. hamulus*** Epling: Epling, 1939; *Hinton 9884** (GH, NY, TEX-LL). ***S. hapalophylla*** Epling: Epling, 1939; *Wasshausen & Salas 1188* (K); *Weberbauer 7858** (F, UC-JEPS). ***S. harleyana*** E. P. Santos: dos Santos, 2004. ***S. hatschbachii*** E. P. Santos: dos Santos, 1994. ***S. heerii*** Regel: Trelease, 1882; Epling, 1939; photo C. Froissart. ***S. helianthemifolia*** Benth.: Epling, 1939; Dieringer et al., 1991; *Rzedowski 47803* (F). ***S. henryi*** A. Gray: Walker & Elisens, 2001; *R. Duncan s.n.* (UCR); *P. Wester 374* (MJG, cult.). ***S. herbacea*** Benth.: Epling, 1939. ***S. hermesiana*** Fern. Alonso: Fernández Alonso, 2002; *Hermes Cuadros 2299** (COL). ***S. herrerae*** Epling: Epling, 1939; *Herrera 3207** (F, UC-JEPS). ***S. heterofolia*** Epling & Mathias: Epling & Mathias, 1957; *Clark 7087** (NY). ***S. heterotricha*** Fernald: Epling, 1939; *Palmer 53** (NY). ***S. hidalgensis*** Miranda: Miranda, 1950; *Miranda 9451* (MEXU); *Medrano et al. 10071* (MEXU); *Rafael H. 6471* (MEXU). ***S. hilarii*** Benth.: Epling, 1939; Epling & Toledo, 1943; *W. Hoehne 4017* (K). ***S. hintonii*** Epling: Epling, 1939; *Hinton 10150** (GH, NY, TEX-LL, US). ***S. hirsuta*** Jacq.: Epling, 1939. ***S. hirta*** Kunth: Epling, 1939; *Hart 1363* (K); *Lewis et al. 2625* (K); *Penland 1200* (UC-JEPS); *Steyermark 53708* (F). ***S. hirtella*** Vahl: Epling, 1939; *Asplund 18001* (K); *Harling et al. 6862* (K); *Schmidt-Lebuhn 395* (K, MJG, cult.). ***S. hispanica*** L.: Epling, 1939; Fernández Alonso, 2003; *Pringle 8837 ½* (TEX-LL); *Williams 41161* (F). ***S. holwayi*** S. F. Blake: Epling, 1939, 1941; Standley & Williams, 1973; Ramamoorthy, 1984a; *Holway 579** (US); *P. Wester 287* (MEXU, MJG, wild), *291* (MJG, wild). ***S. hotteana*** Urb. & Ekman: Epling, 1939; Liogier, 1994; *Ekman H-2415** (NY). ***S. humboldtiana*** F. Dietr.: Epling, 1939.

S. igualensis Fernald: Epling, 1939; *Pringle 8418** (NY, S, TEX-LL). ***S. incumbens*** Urb. & Ekman: Epling, 1939; Liogier, 1973. ***S. incurvata*** Ruiz & Pav.: Ruiz & Pavon, 1798; Epling, 1939. ***S. indigocephala*** Ramamoorthy: Epling, 1940a; Ramamoorthy, 1983b; *Hinton 12792** (NY, TEX-LL). ***S. infuscata*** Epling: Epling, 1939. ***S. innoxia*** Epling & Mathias: Epling & Mathias, 1957. ***S. inornata*** Epling: Epling, 1939; *Purpus 5678** (NY). ***S. integrifolia*** Ruiz & Pav.: Epling, 1939; *Dombey 273** (P, US); *López & Sagástegui 3552* (UC-JEPS); *Lourteig 3262* (K); *Sandeman 5317* (K). ***S. intonsa*** Epling: Epling, 1939; Fernández Alonso, 2003; *Killip 16971* (GH, US). ***S. involucrata*** Cav.: Kunth, 1817; Epling, 1939; Epling & Mathias, 1957; Ramamoorthy, 1984a; *P. Wester* [*580*], *581* (MJG, cult.). ***S. iodantha*** Fernald: Epling, 1939; Dieringer et al., 1991; Lara & Ornelas, 2001; Schondube et al., 2004; Lara, 2006; *Pringle 8039** (NY, US); *P. Wester 212* (MJG, wild), *582* (MJG, cult.). ***S. iodophylla*** Epling: Epling, 1939; *Botteri 793** (K). ***S. ionocalyx*** Epling: Epling, 1939; *Matuda 134** (MO), *Matuda 1903* (K). ***S. itaguassuensis*** Brade & Barb. Per.: Brade & Barbosa, 1946; *Brade 18476** (NY). ***S. iuliana*** Epling: Epling, 1947; dos Santos, 1991; *Steyermark 56450** (UC-JEPS).

S. jacalana B. L. Turner ('*S. tarayensis* K. M. Peterson'): Peterson, 1978; Turner, 2008c, 2008d; *Mayfield et al. 820** (TEX-LL). **S. jacobi** Epling: Epling, 1940a; *Hinton 14110** (NY, TEX-LL). **S. jaimehintoniana** Ramamoorthy ex B. L. Turner: Turner, 1995b; *Burford L. Westlund 5.20.88.24** (TEX-LL). **S. jamaicensis** Fawc.: Epling, 1939; *Harris 7327** (NY). **S. jaramilloi** Fern. Alonso: Fernández Alonso, 2003. **S. jorgehintoniana** Ramamoorthy ex B. L. Turner: Turner, 1995a; *Hinton 21348** (K, TEX-LL).

S. karwinskii Benth.: Epling, 1939; Standley & Williams, 1973; Ramamoorthy, 1984a; Pool, 2001; *P. Wester 236*, *307* (MEXU, MJG, wild), *571* (MJG, cult.). **S. keerlii** Benth.: Epling, 1939; Dieringer et al., 1991; Ramamoorthy, 2001. **S. kellermanii** Donn. Sm.: Epling, 1939, 1951; Epling & Mathias, 1957; Standley & Williams, 1973; Molina, 1975; Pool, 2001; *Kellerman 5628** (TEX-LL), *Maxon & Hay 3569** (US); *Williams & Molina 12232** (MO).

S. lachnaioclada Briq.: Torke, 2000; *Eggers 2594** (B, L); *Ekman H-5086** (NY). **S. lachnostachys** Benth.: Epling, 1939; Epling & Toledo, 1943. **S. lachnostoma** Epling: Epling, 1939. **S. laevis** Benth.: Epling, 1939; *Pringle 4155** (NY); *Purpus 5679** (NY). **S. lamiifolia** Jacq.: Epling, 1939; *Prior s.n.** (K). **S. langlassei** Fernald: Epling, 1939; *Langlassé 216** (P). **S. languidula** Epling: Epling, 1939; *Hinton 10351** (NY, TEX-LL). **S. lanicalyx** Epling: Epling, 1939. **S. lanicaulis** Epling & Játiva: Epling & Játiva, 1963; *López & Sagástegui 2729** (HUT, UC-JEPS); *Sagástegui et al. 8113* (K); *Sánchez Vega 7032* (F). **S. lasiantha** Benth.: Epling, 1939; Dieringer et al., 1991; *Pittier 746** (US); *Rose 2862** (US); *Sousa 1698* (MEXU); *P. Wester 248* (MEXU, MJG, wild), *258* (MJG, wild). **S. lasiocephala** Hook. & Arn.: Epling, 1939; *Palmer 295** (NY); *Smith 1371** (NY). **S. lavanduloides** Kunth: Epling, 1939; Dieringer et al., 1991; Schondube et al., 2004; *P. Wester 282* (MJG, wild). **S. lavendula** Alain: Liogier, 1988; Torke, 2000; *A. H. Liogier 12911** (NY, US). **S. laxispicata** Epling: Epling, 1939. **S. leninae** Epling: Epling, 1941; *Hinton 14897** (ARIZ, GH, NY, TEX-LL, US). **S. lenta** Fernald: Epling, 1939. **S. leptostachys** Benth.: Epling, 1939. **S. leucantha** Cav.: Epling, 1939; Wood & Harley, 1989; Ramamoorthy, 2001; Wester & Claßen-Bockhoff, 2007; *Pringle 8402* (US); *P. Wester 466*, [*583*] (MJG, cult.). **S. leucocephala** Kunth: Epling, 1939; *Asplund 6837* (K), *20501* (TEX-LL); *Camp E-3122* (K); *Lewis & Klitgaard 2298* (K); *Schmidt-Lebuhn 399* (K, MJG, cult.). **S. leucochlamys** Epling: Epling, 1940a. **S. leucophylla** Greene: Epling, 1938; Neisess, 1983; *P. Wester* [*393*] (MJG, wild), [*397*, *399*] (MJG, cult.). **S. libanensis** Rusby: Epling, 1939; Ahlenslager, 1984; Wood & Harley, 1989; *H. H. Smith 1380** (GH, NY, TEX-LL, US); *Viereck s.n.* (K). **S. lineata** Benth.: Epling, 1939; *M. Crone 12* (MJG, cult.); *Purpus 2579** (NY, UC-JEPS). **S. littae** Vis.: Epling, 1939; *P. Wester 281* (MEXU, MJG, wild). **S. lobbii** Epling: Epling, 1939; Luteyn, 1999; Fernández Alonso, 2006; *Lobb 293** (K, W); *Schmidt-Lebuhn 475* (K, MJG). **S. longibracteolata** E. P. Santos: dos Santos, 1994. **S. longispicata** M. Martens & Galeotti: Epling, 1939; Schondube et al., 2004; *Pringle 1798** (NA, NY), *8504** (C, L, S). **S. longistyla** Benth.: Epling, 1939; Dieringer et al., 1991; *P. Wester 268* (MEXU, MJG, wild), *570* (MJG, cult.). **S. lophanthoides** Fernald: Epling, 1939. **S. loxensis** Benth.: Epling, 1939. **S. lozanii** Fernald: Epling, 1939; *Pringle 8928** (C, NY). **S. lycioides** A. Gray: Epling, 1939; *Pringle 52** (GH), *790* (NY). **S. lyrata** L.: Fernald, 1950; Gleason, 1963; *P. Wester* [*361*] (MJG, cult.).

S. macellaria Epling: Epling, 1939; *Schaffner 330/667** (C, GH, NY); *Parry & Palmer 748* (GH). **S. macrocalyx** Gardner: Epling, 1939; dos Santos, 1991. **S. macrophylla** Benth.: Epling, 1939; Wood, 2007; *Asplund 18115* (B); *Schmidt-Lebuhn 446* (K, MJG, cult.). **S. macrostachya** Kunth: Epling, 1939; Wood & Harley, 1989; Fernández Alonso, 2003; *André s.n.* (K); *Asplund 7788* (K); *Holm-Nielson & Quintana 24724* (AAU, K). **S. madrensis** Seem.: Epling, 1944; *Breedlove 35690* (MEXU); *S. Barry David 483* (FLAS); *Seemann 2079** (UC-JEPS); *Taylor & Knees 382* (K); *P. Wester* [*584*], *601* (MJG, cult.). **S. malvifolia** Epling & Játiva: Epling & Játiva, 1963; *R. Moran 3940** (SD). **S. manantlanensis** Ramamoorthy: Ramamoorthy & Lorence, 1987. **S. manaurica** Fern. Alonso: Fernández Alonso, 2002, 2003; *Rangel 11157-A** (COL). **S. marci** Epling: Epling, 1939; Shreve & Wiggins, 1964; Wiggins, 1980; *Carter et al. 2053* (K); *H. S. Gentry 4143* (K, MEXU); *Jones 27298** (UC-JEPS); *R. Moran 7449* (SD). **S. mattogrossensis** Pilg.: Epling, 1939; Epling & Toledo, 1943; dos Santos, 2004. **S. mazatlanensis** Fernald: Epling, 1939. **S. medusa** Epling & Játiva: Epling & Játiva, 1963; Sagástegui et al., 2003; Fernández Alonso, 2006; *López & Sagástegui 3535** (HUT, UC-JEPS); *Sagástegui et al. 16328* (HAO). **S. melaleuca** Epling: Epling, 1939; Wood & Harley, 1989; G. Pérez et al., 2006; *Killip & Smith 19735** (GH, NY); *Wood 3763** (COL), *4330*, *4332*, *4503* (K). **S. melissiflora** Benth.: Epling, 1939; Epling & Toledo, 1943; Epling & Játiva, 1963; dos Santos, 2004; *Dusén 7784** (GH); *Ferreira 28* (K); *Hatschbach 30578* (K); *Kummrow 672* (K); *S. Vogel 1965/604* (WU). **S. melissodora** Lag.: Epling, 1939. **S. mellifera** Greene: Epling, 1938; Grant & Grant, 1964; Neisess, 1983; Reisfield, 1987; *P. Wester 391* (MJG, wild). **S. mendax** Epling: Epling, 1939; Molina, 1975; Neisess, 1983; *Skutch 641* (US). **S. mentiens** Pohl: Pohl, 1827; Epling, 1939; Epling & Toledo, 1943; Epling & Mathias, 1957; Epling & Játiva, 1963; *Anonymous s.n.* (WU 38020); *Ball s.n.* (K). **S. mexiae** Epling: Epling, 1939; *Mexia 1801** (NY). **S. mexicana** L.: Epling, 1939; Wagner, 1946; Des Granges, 1979; Reisfield, 1987; Dieringer et al., 1991; Arizmendi et al., 1996; Lara & Ornelas, 2001; Arizmendi et al., 2007. **S. mexicana** var. **minor** Benth.: *M. Crone s.n.* (MJG); *P. Wester 183* (MEXU, MJG, wild), [*228*] (MJG, wild), *547* (MJG, cult.). **S. mexicana** var. **major** Benth.: *P. Wester 200*, *203*, *263* (MEXU, MJG, wild), *204* (MJG, wild), *548* (MJG, cult.). **S. micrantha** Vahl: Epling, 1939, 1940d; Liogier, 1994; Pool, 2001. **S. microdictya** Urb. & Ekman: Epling, 1939; Liogier, 1994. **S. microphylla** Kunth: Epling, 1939; Grant & Grant, 1968; Standley & Williams, 1973; Van Devender et al., 2004; Wester & Claßen-Bockhoff, 2007; *Hansen 7679* (F); *P. Wester 244* (MEXU, MJG, wild), *155* (MJG, wild), *415*, *526* (var. *wislizenii*, MJG, cult.). **S. minarum** Briq.: dos Santos, 1996. **S. miniata** Fernald: Epling, 1939; 1940a; Standley & Williams, 1973; *Ghiesbreght 760** (GH); *Schipp S-632** (GH); *P. Wester 585* (MJG, cult.). **S. misella** Kunth: Epling, 1939; Liogier, 1994. **S. mocinoi** Benth.: Epling, 1939; Dieringer et al., 1991; Pool, 2001; *Martínez 434* (F); *Pringle 8035** (C, L, NY). **S. modica** Epling: Epling, 1939; *Hinton 22892* (K). **S. mohavensis** Greene: Neisess, 1983; Fenster et al., 2004; *Sanders 369* (UCR); *Ward s.n.* (ASU); *P. Wester 469* (MJG, cult.), *491–494*, *506*, *510*, *516–517* (MJG, wild), *507*, *508* (MJG, UCR, wild), *599* (MJG, cult.); Pinacate-form: *Sanders & Neisess 5658* (UCR); *P. Wester 504* (MJG, UCR, cult.). **S. monantha** Brandegee ex Epling: Epling, 1939. **S. monclovensis** Fernald: Epling, 1939; *Palmer 1096** (GH, US). **S. moniliformis** Fernald: Epling, 1939; *Purpus 170** (NY). **S. montecristina** Urb. & Ekman: Epling, 1939; Liogier, 1994; *Ekman H-13150** (NY). **S. mornicola** Urb. & Ekman: Epling, 1939; Liogier, 1994; *Ekman H-4940** (US). **S. mucidiflora** Fernald: Epling, 1939; *Palmer 187** (C, NY). **S. muelleri** Epling: Epling, 1939; *Mueller 145** (TEX-

LL). ***S. munzii*** Epling: Epling, 1938; Shreve & Wiggins, 1964; Neisess, 1983; *Epling & Robinson s.n.** (TEX-LL); *P. Wester 436* (MJG, cult.). ***S. muscarioides*** Fernald: Epling, 1939.

S. nana Kunth: Epling, 1939. ***S. neovidensis*** Benth.: Epling, 1939; *Prinz Maximilian zu Wied s.n.** (GOET). ***S. nepetoides*** Kunth: Epling, 1939. ***S. nervata*** M. Martens & Galeotti: Epling, 1939; Wester & Claßen-Bockhoff, 2007; *Nelson 3635** (US); *P. Wester 292* (BIGU, MEXU, MJG, wild). ***S. nervosa*** Benth.: Epling, 1939; dos Santos, 1996. ***S. nigrescens*** Alain (nom. illeg.): Liogier, 1956; *A. H. Liogier 3706** (NY). ***S. nitida*** (M. Martens & Galeotti) Benth.: Epling, 1939. ***S. novoleontis*** B. L. Turner: Turner, 2009b; *Hernandez et al. 2681** (TEX-LL). ***S. nubigena*** J. R. I. Wood & Harley: Wood & Harley, 1989; *Wood 5251** (COL), *5269* (K). ***S. nubilorum*** Epling & Játiva: Epling & Játiva, 1968; *Steyermark 96943** (UC-JEPS).

S. oaxacana Fernald: Epling, 1939; *P. Wester 259* (MEXU, MJG, wild). ***S. oblongifolia*** M. Martens & Galeotti: Epling, 1939. ***S. obtorta*** Epling: Epling, 1939. ***S. obumbrata*** Epling: Epling, 1939; *Killip & Smith 25311** (F, US). ***S. occidentalis*** Sw.: Epling, 1939; Wiggins, 1971; Liogier, 1994. ***S. occidua*** Epling: Epling, 1939; *Liebmann 15697** (C). ***S. occultiflora*** Epling: Epling, 1939; *Jahn 670** (US). ***S. ochrantha*** Epling: Epling, 1939; Epling & Mathias, 1957; Epling & Játiva, 1963; *Lewis 3145* (K); *López 1043*, *3183* (HUT). ***S. ocimifolia*** Epling: Epling, 1939; *Eggers 15053** (LD, US). ***S. oligantha*** Dusén: Epling, 1939; Epling & Toledo, 1943; *Dusén 234* (K, S); *Freitas 451*, *471* (K); *S. Vogel 1965/681* (WU). ***S. ombrophila*** Dusén: Epling, 1939; Brade, 1943; Epling & Toledo, 1943; Epling & Mathias, 1957; *dos Santos 132* (K); *Harley 20346*, *20346a*, *20342* (K). ***S. opertiflora*** Epling: Epling, 1941; *Steyermark 31469* (US). ***S. ophiocephala*** J. R. I. Wood: Wood, 2007. ***S. oppositiflora*** Ruiz & Pav.: Ruiz & Pavón, 1798; Epling, 1939; Macbride, 1960; *Pennell 13534* (F); *Schmidt-Lebuhn 423*, *464* (K, MJG, cult.). ***S. orbignaei*** Benth.: Epling, 1939, 1947; Wester & Claßen-Bockhoff, 2007; Wood, 2007; *P. Wester 39–42*, *44*, *45*, *47*, *48*, *51* (MJG, wild, div. cult.), *50* (K, LPB, MJG, wild). ***S. oreopola*** Fernald: Epling, 1939; *Pringle 7643* (US); *P. Wester 185* (MJG, wild). ***S. oresbia*** Fernald: Epling, 1939; *Parry & Palmer 740** (GH, NY); *Schaffner 333/666** (C, GH, GOET, MEXU, NY). ***S. orthostachys*** Epling: Epling, 1939; Wood & Harley, 1989; Fernández Alonso, 1995a; *Killip & Smith 20746** (GH); *Wood 4175** (COL), *4510* (K). ***S. ovalifolia*** A. St.-Hil. ex Benth.: Epling, 1939; dos Santos, 1996; *Hassler 4294** (NY). ***S. oxyphora*** Briq.: Epling, 1939; Wood, 2007; *P. Wester 16* (LPB, MJG, wild, cult.).

S. pachyphylla Epling ex Munz: Epling, 1938; Neisess, 1983; *P. Wester 500*, *502*, *519*, *520*, *521* (MJG, wild), *402*, *471*, *488* (MJG, cult.). ***S. pachypoda*** Briq.: dos Santos, 1996. ***S. palealis*** Epling: Epling, 1940a; *Hinton 14040** (K, NY, UC-JEPS, US). ***S. palifolia*** Kunth: Epling, 1939. ***S. pallida*** Benth.: Epling, 1939. ***S. palmeri*** A. Gray: Epling, 1939; *Palmer 259** (NY). ***S. pamplonitana*** Fern. Alonso: Fernández Alonso, 2003. ***S. pannosa*** Fernald: Epling, 1939; Dieringer et al., 1991; *Pringle 8593** (NY). ***S. pansamalensis*** Donn. Sm.: Epling, 1939; *von Türckheim 933** (GH, K, NY, US). ***S. paposana*** Phil.: Epling, 1939; *King 294* (F); *Soukup 1282* (F). ***S. paraguariensis*** Briq.: Epling, 1939; dos Santos, 1996; *Hassler 9237** (NY). ***S. paramicola*** Fern. Alonso: Fernández Alonso, 1995b, 2003; *J. Aguirre 850** (COL). ***S. parciflora*** Urb.: Epling, 1939; Liogier, 1994. ***S. parryi*** A. Gray: Epling, 1939. ***S. paryskii*** Skean & Judd: Skean & Judd, 1988; Torke, 2000; *Skean 2096** (GOET). ***S. patens*** Cav.: Epling, 1939; *P. Wester 563*, [*593*] (MJG, cult.). ***S. pauciserrata*** Benth.: Epling, 1939; Epling & Mathias, 1957; Wood & Harley, 1989; *Hartweg 1327** (P); *Lehmann 5826* (K); *Schmidt-Lebuhn 369* (subsp. *calocalicina*, K, MJG, cult.); *P. Wester 555* (subsp. *calocalicina*, MJG, cult.). ***S. paulwalleri*** B. L. Turner: Turner, 2009b; *Shannon 94** (TEX-LL). ***S. paupercula*** Epling: Epling, 1939. ***S. pavonii*** Benth.: Epling, 1939, 1941; *Lobb 82* (K); *McLean s.n.* (K); *Saunders 689* (K); *Stork 10956* (F). ***S. penduliflora*** Epling: Epling, 1939; *Weberbauer 7910** (F). ***S. peninsularis*** Brandegee: Epling, 1939; Shreve & Wiggins, 1964; Wiggins, 1980; *Brandegee s.n.** (UC-JEPS); *R. Moran 18786* (SD); photo J. Rebman (SD). ***S. pennellii*** Epling: Epling, 1939; *Pennell 17538** (GH, UC-JEPS, US). ***S. pentstemonoides*** Kunth & C. D. Bouché: Kunth & Bouché, 1848; Bentham, 1876; Gray, 1886; Correll & Johnston, 1970; Walker et al., 2004; Walker & Sytsma, 2007; *Lindheimer 460** (NY); *P. Wester* [*586*] (MJG, cult.). ***S. perblanda*** Epling: Epling, 1939; *Hinton 9946** (NY, TEX-LL). ***S. peregrina*** Epling: Epling, 1951; *Espinosa 1591** (UC-JEPS). ***S. pericona*** B. L. Turner: Turner, 2009a; *García et al. 2342** (TEX-LL). ***S. perlonga*** Fernald: Epling, 1939, 1947; *Breedlove 61837* (MEXU); *Nelson 2186** (GH, UC-JEPS, US); *P. Wester 273* (MJG, wild), *645* (MJG, cult.). ***S. perlucida*** Epling: Epling, 1939; *Killip 22350** (F). ***S. perplicata*** Epling: Epling, 1939; *Rose 13876** (NY). ***S. persicifolia*** A. St.-Hil.: Epling, 1939; dos Santos, 1991. ***S. personata*** Epling: Epling, 1939; Wood, 2007; *P. Wester 17* (LPB, MJG, wild, cult.). ***S. pexa*** Epling: Epling, 1939; Ramamoorthy & Elliott, 1998. ***S. phaenostemma*** Donn. Sm.: Epling, 1939; *Nelson 3736** (US). ***S. pichinchensis*** Benth.: Mansfeld, 1937; Epling, 1939; Fernández Alonso, 2006; Schmidt-Lebuhn, pers. comm.; *Jameson 797** (K, US); *Ollgard & Balslev 9815* (K); *Schmidt-Lebuhn 381* (K, MJG). ***S. pineticola*** Epling: Epling, 1941. ***S. pinguifolia*** (Fernald) Woot. & Standl.: Standley, 1924; Epling, 1939; Shreve & Wiggins, 1964; *Goldman 1501** (US); *Palmer 7* (NY). ***S. pinosiana*** Gladkova: Gladkova, 1996. ***S. platycheila*** A. Gray: Epling, 1939; Shreve & Wiggins, 1964; *Palmer 7* (US). ***S. platyphylla*** Briq.: Epling, 1939; *Pringle 2560** (NA, NY). ***S. plumosa*** Ruiz & Pav.: Ruiz & Pavon, 1798; Epling, 1939; *Dombey 270** (F, L, SEV). ***S. plurispicata*** Epling: Epling, 1939; *Hinton 13549* (F). ***S. podadena*** Briq.: Epling, 1939. ***S. polystachya*** Cav.: Epling, 1939; Wagner, 1946; Dieringer et al., 1991; *Pringle 3224** (NY), *13279** (MICH, TEX-LL, US). ***S. potus*** Epling: Epling, 1939. ***S. praestans*** Epling: Epling, 1940a; *Hinton 11095** (K, MO, UC-JEPS, US); *Hinton 14765** (UC-JEPS); *Martínez 5715* (MEXU, TEX-LL, XAL). ***S. praeterita*** Epling: Epling, 1939; *Ekman H-13963** (NY). ***S. prasiifolia*** Benth.: Epling, 1939. ***S. primuliformis*** Epling: Epling, 1939; Liogier, 1994; *Ekman H-9230** (C, NY, TEX-LL). ***S. pringlei*** B. L. Rob. & Greenm.: Epling, 1939; *Pringle 4564** (K, NY, P, TEX-LL, US); *Reveal 4029* (TEX-LL; and photos). ***S. procurrens*** Benth.: Epling, 1939; Epling & Toledo, 1943; Suarez, 1965. ***S. propinqua*** Benth.: Epling, 1939; dos Santos, 1996. ***S. prostrata*** Hook. f.: Epling, 1939; Wiggins, 1971. ***S. protracta*** Benth.: Epling, 1939; Dieringer et al., 1991; Espejo Serna & Ramamoorthy, 1993; *Mexia 1583** (NY); *Pringle 6013** (L, NY); *P. Wester 264* (MJG, wild). ***S. pruinosa*** Fernald: Epling, 1939. ***S. prunelloides*** Kunth: Epling, 1939; *Humboldt & Bonpland s.n.** (P); *Pringle 9159* (F). ***S. pseudoincisa*** Epling: Epling, 1940a. ***S. pseudomisella*** Moran & G. A. Levin: Levin & Moran, 1989; *Moran 29522** (NY). ***S. pseudopallida*** Epling: Epling, 1940a; *Muller 3226** (TEX-LL, US). ***S. pseudoprivoides*** Epling:

Epling, 1939. ***S. pseudorosmarinus*** Epling: Epling, 1941; *Stork 9968** (F, UC-JEPS). ***S. pseudoserotina*** Epling: Epling, 1939; Wiggins, 1971; Harley, 1999; *Darwin s.n.* (CGE). ***S. psilantha*** Epling: Epling, 1939; *Weberbauer 6590** (F, GH, UC-JEPS). ***S. psilostachya*** Epling: Epling, 1939; *Weberbauer 7141** (F, GH, UC-JEPS, US). ***S. pteroura*** Briq.: Epling, 1939. ***S. pubescens*** Benth.: Ahlenslager, 1984; *P. Wester 276* (MJG, wild). ***S. pulchella*** DC.: Epling, 1939; Ramamoorthy, 2001; *Pringle 8674** (MO, NY, P, TEX-LL, US). ***S. punctata*** Ruiz & Pav.: Epling, 1939. ***S. purpurea*** Cav.: Epling, 1939; Dieringer et al., 1991; Ramírez & Martínez, 1998; Ortiz-Pulido et al., 2002; *M. Crone s.n.* (MJG); *P. Wester 174*, *190* (MEXU, MJG, wild), *205*, *206*, *216*, *217*, *242*, *243*, [*229*, *260*, *286*] (MJG, wild). ***S. purpusii*** Brandegee: Epling, 1939. ***S. pusilla*** Fernald: Epling, 1939.

S. quercetorum Epling: Epling, 1939. ***S. quitensis*** Benth.: Lagerheim, 1899; Epling, 1939; *Fleming 36* (K); *Harling 6827* (F); *Jameson 711** (K, NY, P).

S. ramamoorthyana Espejo: Espejo Serna & Ramamoorthy, 1993; *Reveal 4106** (NY, TEX-LL). ***S. ramosa*** Brandegee: Epling, 1939; Turner, 2009a; *Purpus 2578** (UC-JEPS), *3288** (NY). ***S. raveniana*** Ramamoorthy: Ramamoorthy, 1984b; *Calzada 21603* (MEXU); *Manzanero 241* (OAX); *Ramamoorthy 4488* (K, MEXU); *Reyes 797* (MEXU); *Torres et al. 1926* (MEXU). ***S. raymondii*** J. R. I. Wood: Wood, 2007; *P. Wester 1* (MJG, wild). ***S. recurva*** Benth.: Epling, 1939; Reisfield, 1987. ***S. reflexa*** Hornem.: Epling, 1939. ***S. regla*** Cav.: Ahlenslager, 1984; *P. Wester 255* (MJG, wild), *356* (MJG, cult.). ***S. regnelliana*** Briq.: Briquet, 1904; Epling, 1939; Epling & Toledo, 1943; *Lindman 1261** (S). ***S. reitzii*** Epling: Epling, 1960. ***S. remissa*** Epling: Epling, 1939; *Mexia 1559** (NY). ***S. remota*** Benth.: Epling, 1939. ***S. reptans*** Jacq.: Peterson, 1978; Ramamoorthy, 2001. ***S. retinervia*** Briq.: Epling, 1939; Wood, 2007; *P. Wester 30* (LPB, MJG, wild). ***S. revoluta*** Ruiz & Pav.: Epling, 1939; *Macbride 3041* (F). ***S. rhinosina*** Griseb.: Epling, 1939; Wood, 2007. ***S. rhodostephana*** Epling: Epling, 1939, 1941; *Killip & Smith 23323** (UC-JEPS, NY, US); *Wasshausen & Encarnacíon 568* (K). ***S. rhombifolia*** Ruiz & Pav.: Epling, 1939; Wood, 2007; *Dombay s.n.** (P); *Lobb 293** (K). ***S. rhyacophila*** Epling: Epling, 1939; Dieringer et al., 1991. ***S. richardsonii*** B. L. Turner: Turner, 2008c, 2008d; *Richardson 1050** (TEX-LL). ***S. rivularis*** Gardner ex H. B. Fielding: Epling, 1939; Brade, 1943; dos Santos, 1991; *Brade 16371* (K); *Martinelli 12029* (K); *E. Pereira 247* (K). ***S. roemeriana*** Scheele: Walker & Elisens, 2001; *P. Wester 347*, *350*, *371*, [*348*] (MJG, wild), *564* (MJG, cult.). ***S. roscida*** Fernald: Epling, 1939; *Goldman 340** (NY). ***S. rosei*** Fernald: Fernald, 1900; Epling, 1939; *J. N. Rose 2844** (GH, US). ***S. rosmarinoides*** A. St.-Hil. ex Benth.: dos Santos, 1996; *Saint-Hilaire 2640** (P). ***S. rostellata*** Epling: Epling, 1939. ***S. rubescens*** Kunth: Epling, 1939; Wood & Harley, 1989; *Humboldt & Bonpland s.n.** (P); *P. Wester 442* (MJG, cult.); *Wood 4161** (COL). ***S. rubrifaux*** Epling: Epling, 1951; Jørgensen & Ulloa Ulloa, 1994; *Vargas 6955** (K, UC-JEPS). ***S. rubriflora*** Epling: Epling, 1951; Wood & Harley, 1989; Fernández Alonso, 2003; *Haught 5944** (COL, P, US); *Fernández Alonso & G. Perez 12600A* (K, MEXU); *Wood 3979*, *4580*, *4942* (K). ***S. rubropunctata*** B. L. Rob. & Fernald: Epling, 1939. ***S. rufula*** Kunth: Epling, 1939, 1941; Wood & Harley, 1989; Jørgensen & Ulloa Ulloa, 1994; Harley, 1999; *Cuatrecasas 8184** (F); *Hartweg 1326** (LD); *Rusby & Pennell 574** (NY); *Wood 5181** (COL), *4906*, *5200*, *5347* (K). ***S. rupicola*** Fernald: Epling, 1939. ***S. rusbyi*** Britton ex Rusby: Epling, 1939; *Bang 422* (NY); *Beck 9299*, *18308* (K); *Gentry et al. 44226* (K); *Rusby 2414** (NY); *Solomon 9378* (K); *Solomon & Nee 12612* (K); *Solomon & Stein 11720* (K); *Solomon & Uehling 12228* (K); *Wasshausen & Salas 1206* (K); *Wood 13015* (K); *Wood & Mondaca 14545*, *14574* (K); *Wood & Wasshausen 13755*, *13928* (K); *P. Wester 31* (LPB, MJG, wild). ***S. rypara*** Briq.: Epling, 1939; Wood, 2007; *P. Wester 21*, *33* (MJG, wild), *18*, *32* (LPB, MJG, wild, cult.). ***S. rzedowskii*** Ramamoorthy: Ramamoorthy, 1984c.

S. saccifera Urb. & Ekman: Epling, 1939; Liogier, 1994. ***S. sacculus*** Epling: Epling, 1939. ***S. sagittata*** Ruiz & Pav.: Epling, 1939; Dorst, 1956; Wood & Harley, 1989; *Schmidt-Lebuhn 331* (K, MJG, cult.); *P. Wester 495* (MJG, cult.). ***S. salicifolia*** Pohl: Epling, 1939; Epling & Toledo, 1943; dos Santos et al., 2005; *Glaziou 18279* (P); *Irwin et al. 29119* (K). ***S. sanctae-luciae*** Seem.: Epling, 1939. ***S. sapinea*** Epling: Epling, 1941; Dieringer et al., 1991; *Hinton 14798** (NY, TEX-LL). ***S. sarmentosa*** Epling: Epling, 1939; *Pennell 13650** (F); *Vargas 297* (F). ***S. scabrata*** Britton & P. Wilson: Epling, 1939; *J. A. Shafer 4075** (NY; slides with flowers in UC-JEPS). ***S. scabrida*** Pohl: Epling, 1939; Epling & Toledo, 1943; dos Santos & Harley, 2004; *Arbo M. M. et al. 5248* (K); *Irwin et al. 25759* (K); *R. L. Mendonsa 305* (K). ***S. scandens*** Epling: Epling, 1939, 1944; *Weberbauer 7796** (US). ***S. scaposa*** Epling: Epling, 1939; *Hinton 5332** (NY, TEX-LL). ***S. sciaphila*** (J. R. I. Wood & Harley) Fern. Alonso: Wood & Harley, 1989; Fernando Alonso, 2003. ***S. scoparia*** Epling: Epling, 1960; *Reitz & Klein 17.831* (P). ***S. scutellarioides*** Kunth: Epling, 1939; Rasmussen, 2004; *Schmidt-Lebuhn 349*, *380*, *469* (K, MJG, cult.). ***S. scytinophylla*** Briq.: dos Santos, 1996; *Hassler 4532** (NY), *4725** (P). ***S. secunda*** Benth.: Epling, 1939, 1940a; dos Santos, 2004; *Forzza et al. 2841* (K); *Regnell III 932** (P); *Vauthier 408** (G, L). ***S. seemannii*** Fernald: Epling, 1939. ***S. selguapensis*** Ant. Molina: Molina, 1974. ***S. selleana*** Urb.: Epling, 1939; Liogier, 1994; Torke, 2000; *Buch 1145** (NY); *Fisher-Meerow 639* (FLAS); *Judd 4861* (FLAS). ***S. sellowiana*** Benth.: Epling, 1939; Epling & Toledo, 1943; *G. Gottsberger 36-9966*, *21-9477* (K); *I. Gottsberger & G. Gottsberger 125-16471* (K); *Hatschbach & Pereira 11442*, *11445* (K); *Hunt 6396* (K, P); *S. Vogel 1956/658* (WU). ***S. semiatrata*** Zucc.: Epling, 1939; Dieringer et al., 1991; *P. Wester 274*, *275* (MJG, wild). ***S. serotina*** L.: Epling, 1939; *Parry & Palmer 751** (GH); *Pere Duss 265* (P). ***S. serpyllifolia*** Fernald: Epling, 1939; *Parry 751** (NY). ***S. serranoae*** J. R. I. Wood: Wood, 2007. ***S. sessei*** Benth.: Ahlenslager, 1984; Wester & Claßen-Bockhoff, 2007; *P. Wester* [*175*] (MJG, wild), *179*, *219* (MEXU, MJG, wild). ***S. setosa*** Fernald: Epling, 1939; *Palmer 64** (K). ***S. setulosa*** Fernald: Epling, 1939; *Pringle 8403** (NY). ***S. shannonii*** Donn. Sm.: Epling, 1939. ***S. sharpii*** Epling & Mathias: Epling & Mathias, 1957; *Sharp 50132** (UC-JEPS). ***S. sigchosica*** Fern. Alonso: Fernández Alonso, 2006. ***S. silvarum*** Epling: Epling, 1939; *Killip 25612** (UC-JEPS); *Palmer 61* (K); *Schmidt-Lebuhn 545* (K, MJG). ***S. similis*** Brandegee: Epling, 1939. ***S. sinaloensis*** Fernald: Epling, 1939; Turner, 2009b. ***S. sochensis*** (J. R. I. Wood & Harley) Fern. Alonso: Fernández Alonso, 2003; see also Appendix 3; *Wood 5154** (COL). ***S. sonomensis*** Greene: Epling, 1938; Neisess, 1983; *P. Wester 431* (MJG, cult.). ***S. sophrona*** Briq.: Epling, 1939; Wood, 2007; *S. Vogel 1965/417* (WU); *P. Wester 34*, *34a* (LPB, MJG, wild). ***S. sordida*** Benth.: Epling, 1939; Wood & Harley, 1989; Fernández Alonso, 2003; *Hartweg 1324** (LD), *Wood 4632* (K). ***S. sparsiflora*** Epling: Epling, 1944. ***S. spathacea*** Greene: Grant & Grant, 1968; Neisess, 1983; Wester & Claßen-Bockhoff, 2007; *P. Wester 444* (MJG, wild), [*400*], *544* (MJG, cult.). ***S. speciosa*** C.

Presl ex Benth.: Epling, 1939; *Ferreyra 14628* (K); *Macbride 1212* (F); *Sagástegui et al. 15681* (TEX-LL); *Sagástegui 9062* (K); *Sanchez Vega 2253* (CHAPA); *Sandeman 4638* (K). ***S. speirematoides*** C. Wright: Epling, 1939; *Wright 3657** (GH), *3757* (NY), *s.n.* (K). ***S. sphacelifolia*** Epling: Epling, 1939. ***S. sphacelioides*** Benth.: Epling, 1939; Wood & Harley, 1989; Fernández Alonso, 2003; *Smith 1381** (GH, NY, P, TEX-LL, US); *Wood 4975* (K), *5010** (COL). ***S. splendens*** Sellow ex Roem. & Schult.: Trelease, 1881; Epling, 1939; Epling & Toledo, 1943; dos Santos, 2004; Wester & Claßen-Bockhoff, 2007; *P. Wester 557* (MJG, cult.). ***S. sprucei*** Briq.: Epling, 1939; *Camp E-3974* (K); *Spruce 5990** (P). ***S. squalens*** Kunth: Kunth, 1817; Epling, 1939; Epling & Játiva, 1963; *Hutchinson & Wright 5432* (P); *P. Wester 498*, *592* (MJG, cult.). ***S. stachydifolia*** Benth.: Epling, 1939; Wood, 2007; *P. Wester 35* (LPB, MJG, wild, cult.). ***S. stachyoides*** Kunth: Epling, 1939; Dieringer et al., 1991. ***S. stolonifera*** Benth.: Bentham, 1839–1857; Epling, 1939; Lyon, 1976; Ramamoorthy, 1984a; *Hartweg 70** (L); *Pringle 4705* (UC-JEPS); *P. Wester 247* (MEXU, MJG, wild). ***S. striata*** Benth.: Epling, 1939; Macbride, 1960; *Schmidt-Lebuhn 575* (K, MJG, cult.), *s.n.* (MJG, cult.); *Stork & Horton 10667* (F). ***S. strobilanthoides*** C. Wright ex Griseb.: Epling, 1939; *Wright 3156** (GH, UC-JEPS). ***S. styphelus*** Epling: Epling, 1939; *Schmidt-Lebuhn 495* (K, MJG, cult.); *Smith 7356* (F). ***S. subaequalis*** Epling: Epling, 1939; Liogier, 1994; *Ekman H-8657a** (NY). ***S. subglabra*** (Urb.) Urb.: Epling, 1939; Liogier, 1994. ***S. subhastata*** Epling: Epling, 1939, 1940a; *Langlassé 570** (K). ***S. subincisa*** Benth.: Epling, 1939; *Hartweg 160** (K, L, NY). ***S. subobscura*** Epling: Epling, 1940a; *Hinton 12570** (NY, TEX-LL). ***S. subpatens*** Epling: Epling, 1939; *Hinton 4376** (GH, K, UC-JEPS, US). ***S. subrotunda*** A. St.-Hil. ex Benth.: Epling, 1939; *Balansa 1156** (P); *Saint-Hilaire B1024** (P); *S. Vogel 1965/551* (WU). ***S. subrubens*** Epling: Epling, 1939; Standley & Williams, 1973; *Heyde & Lux 3120** (US, UC-JEPS). ***S. subscandens*** Epling & Játiva: Epling & Játiva, 1968; *Hutchinson & Wright 3421** (UC-JEPS). ***S. sucrensis*** J. R. I. Wood: Wood, 2007; *P. Wester 142* (LPB, MJG, wild). ***S. summa*** A. Nelson: Walker & Elisens, 2001; *P. Wester 373* (MJG, cult.). ***S. synodonta*** Epling: Epling, 1940a; *Hinton 12576** (MO, NY, TEX-LL).

S. tafallae Benth.: Epling, 1939; Wood, 2007. ***S. tehuacana*** Fernald: Epling, 1939; *Pringle 8587** (TEX-LL). ***S. tenella*** Sw.: Epling, 1939; Liogier, 1994. ***S. tenorioi*** Ramamoorthy ex B. L. Turner: Turner, 2009a; *Tenorio & Frame 12291* (MEXU). ***S. tenuiflora*** Epling: Epling, 1939, 1960; *F. Müller 446* (K). ***S. tepicensis*** Fernald: Epling, 1939; *Palmer 1984** (NY). ***S. teresae*** Fernald: Epling, 1939. ***S. texana*** (Scheele) Torr.: Whitehouse, 1949; *P. Wester 351*, *362* (MJG, wild). ***S. textitlana*** B. L. Turner: Turner, 2009b. ***S. thomasiana*** Urb.: Epling, 1939. ***S. thormannii*** Urb.: Torke, 2000; *Torke 105* (FLAS); *v. Türckheim 3611** (K, L, P). ***S. thymoides*** Benth.: Epling, 1939; Dieringer et al., 1991. ***S. thyrsiflora*** Benth.: Epling, 1939; Dieringer et al., 1991; *Pringle 4097* (F). ***S. tiliifolia*** Vahl: Epling, 1939; Wood & Harley, 1987; Wood, 2007; *Pringle 8381** (TEX-LL); *P. Wester 36* (LPB, MJG, wild). ***S. tolimensis*** Kunth: Epling, 1939; Wood & Harley, 1989; *Purdie s.n.* (K); *Wood 5086* (K). ***S. tomentella*** Pohl: Pohl, 1827; Epling, 1939; Epling & Toledo, 1943; *Claussen 1538* (P); *Hatschbach et al. 36223* (K). ***S. tonalensis*** Brandegee: Epling, 1939; *Purpus 7006** (NY). ***S. tortuensis*** Urb.: Epling, 1939; Liogier, 1994. ***S. tortuosa*** Kunth: Epling, 1939; Gilli, 1983; Wood & Harley, 1989; see also Appendix 3; *E. W. D. & M. M. Holway 889** (US); *Humboldt & Bonpland s.n.** (P); *W. Jameson 685* (P); *Schmidt-Lebuhn 350*, *351* (K, MJG, cult.); *Gilli 284** (*S. corazonica* Gilli, W). ***S. townsendii*** Fernald: Epling, 1939; *Tenorio & Romero 1872* (K); *C. H. T. Townsend & Barber 426** (GH, MO, NY, P). ***S. trachyphylla*** Epling: Mansfeld, 1937; Epling, 1939; *Grubb et al. 224* (K); *Harling et al. s.n.* (K); *Pachano 202** (US). ***S. trichopes*** Epling: Epling, 1941; *Woodson & Schery 693** (GH, MO). ***S. trichostephana*** Epling: Epling, 1941; *Gentry 5846** (MO, UC-JEPS). ***S. tricuspidata*** M. Martens & Galeotti: Epling, 1939. ***S. trifilis*** Epling: Epling, 1941; *Stork & Horton 10105** (F). ***S. tubifera*** Cav.: Cavanilles, 1791; Epling, 1939, 1941; Ramamoorthy, 1984c; *P. Wester 231* (B, BIGU, JEPS, K, MEXU, MJG, TEX, wild). ***S. tubiflora*** Sm.: Ruiz & Pavón, 1798; Epling, 1939; Macbride, 1960; *Dombey s.n.** (P); photo Froissart. ***S. tubulosa*** Epling: Epling, 1939; *Pearce 261** (K); *Smith et al. 1779* (K). ***S. tuerckheimii*** Urb.: Torke, 2000; *von Türckheim 2896** (L, NY, US); *Ekman H-13625** (GH, K, NY, S, TEX-LL, US), *H-13947** (K, S). ***S. turneri*** Ramamoorthy: Turner, 1996b. ***S. tuxtlensis*** Ramamoorthy: Ramamoorthy, 1984d.

S. uliginosa Benth.: Epling, 1939; *P. Wester 588* (MJG, cult.). ***S. umbraticola*** Epling: Epling, 1939. ***S. umbratilis*** Fernald: Epling, 1939; *Langlassé 904** (GH, K, P). ***S. uncinata*** Urb.: Torke, 2000; *Ekman H13760** (K); *Howard & Howard 9155* (UC-JEPS). ***S. unguella*** Epling: Epling, 1940a; *Penland 1173** (COLO). ***S. unicostata*** Fernald: Epling, 1939; *Parry 760** (NY). ***S. univerticillata*** Ramamoorthy ex Klitg.: Klitgaard, 2007; *P. Wester 423* (MJG, cult.), *594* (MEXU, MJG, cult.). ***S. uribei*** J. R. I. Wood & Harley: Wood & Harley, 1989; *Wood 4939** (COL). ***S. urica*** Epling: Epling, 1939. ***S. urolepis*** Fernald: Epling, 1939. ***S. urticifolia*** L.: Epling, 1939; *Clayton 292** (BM). ***S. uruapana*** Fernald: Epling, 1939; *Pringle 13280** (TEX-LL).

S. vargasii Epling: Epling, 1947. ***S. vaseyi*** (Porter) Parish: Epling, 1938; Shreve & Wiggins, 1964; Neisess, 1983; *P. Wester 408*, *409*, *465* (MJG, wild). ***S. venulosa*** Epling: Epling, 1939; Wood & Harley, 1989; *Pennell 10616** (US); *Wood 5381*, *5384* (K). ***S. verapazana*** B. L. Turner: Turner, 1996a; *Contreras 11224** (TEX-LL). ***S. verecunda*** Epling: Epling, 1939. ***S. veronicifolia*** A. Gray ex S. Watson: Epling, 1939; *Palmer 28** (NY). ***S. vestita*** Benth.: Bentham, 1848; Epling, 1939; *Lobb s.n.** (K). ***S. villosa*** Fernald: Epling, 1939. ***S. viscida*** A. St.-Hil. ex Benth.: Epling, 1939; dos Santos, 1996; *Saint-Hilaire 34** (P). ***S. viscidifolia*** Epling: Epling, 1940a; *Hinton 10725**, *12369* (K). ***S. vitifolia*** Benth.: Epling, 1939; *Reveal et al. 4191* (K).

S. wagneriana Pol.: Epling, 1939, 1940b; Nowicke & Epling, 1969; Standley & Williams, 1973; Ramamoorthy, 1984a; Pool, 2001; *P. Wester 285* (BIGU, MEXU, MJG, wild), *443* (MJG, cult.); *White & White 321* (MO). ***S. weberbaueri*** Epling: Epling, 1939; *Weberbauer 6638** (GH). ***S. whitefoordiae*** Klitg.: Klitgaard, 2007. ***S. whitehousei*** Alziar: Whitehouse, 1949; *Correll D. S. 38529* (TEX-LL); *McVaugh 7930* (P); *P. Wester 352* (MJG, TEX, wild), *353*, *367*, *524* (MJG, wild).

S. xalapensis Benth.: Epling, 1939; *v. Schlechtendal 93** (NY). ***S. xanthophylla*** Epling & Játiva: Epling & Játiva, 1963; *Hutchinson 6185* (P); *López & Sagástegui 2730** (HUT). ***S. xanthotricha*** Harley ex E. P. Santos: dos Santos, 2004. ***S. xeropapillosa*** Fern. Alonso: Fernández Alonso, 1995a, 2003; *Langenheim 3584** (COL).

S. yukoyukparum Fern. Alonso: Fernández Alonso, 2008.

S. zacualpanensis Briq.: Epling, 1939. ***S. zacuapanensis*** Brandegee: Epling, 1939; *Purpus 1932* (GH, US). ***S. zaragozana*** B. L. Turner: Turner, 2008c, 2008d.

APPENDIX 2. Pollination syndromes of New World *Salvia* species.

ORNITHOPHILOUS (184 SPP.)

S. acuminata Ruiz & Pav., *S. adenophora* Fernald, *S. alborosea* Epling & Játiva, *S. altimitrata* Epling, *S. altissima* Pohl, *S. apparicii* Brade & Barb. Per., *S. arbuscula* Fernald, *S. arduinervis* Urb. & Ekman, *S. articulata* Epling, *S. atrocaulis* Fernald, *S. atrocyanea* Epling, *S. ayavacensis* Kunth

S. bahorucona Urb. & Ekman, *S. balaustina* Pohl, *S. benthamiana* Gardner, *S. betulifolia* Epling, *S. blepharophylla* Brandegee ex Epling, *S. booleana* B. L. Turner, *S. buchananii* Hedge

S. cacaliifolia Benth., *S. camarifolia* Benth., *S. chapadensis* E. P. Santos & Harley, *S. cinnabarina* M. Martens & Galeotti, *S. clarkcowanii* B. L. Turner, *S. coccinea* Buc'hoz ex Etl., *S. cocuyana* Fern. Alonso, *S. confertiflora* Pohl, *S. cubensis* Britton & P. Wilson, *S. curtiflora* Epling, *S. curviflora* Benth., *S. cyanocephala* Epling, *S. cylindriflora* Epling

S. darcyi J. Compton, *S. diamantina* E. P. Santos & Harley, *S. disjuncta* Fernald, *S. divinorum* Epling & Játiva, *S. dombeyi* Epling, *S. dorisiana* Standl., *S. dugesiana* Epling

S. elegans Vahl, *S. ernesti-vargasii* C. Nelson, *S. erythrostephana* Epling, *S. espirito-santensis* Brade & Barb. Per., *S. exserta* Griseb.

S. falcata J. R. I. Wood & Harley, *S. florida* Benth., *S. formosa* L'Hér., *S. foveolata* Urb. & Ekman, *S. fruticetorum* Benth., *S. fulgens* Cav., *S. funckii* Briq.

S. gachantivana Fern. Alonso, *S. gesneriiflora* Lindl. & Paxton, *S. graciliramulosa* Epling & Játiva, *S. grandis* Epling, *S. gravida* Epling, *S. greggii* A. Gray, *S. grewiifolia* S. Moore, *S. guaranitica* A. St.-Hil. ex Benth.

S. haenkei Benth., *S. hapalophylla* Epling, *S. harleyana* E. P. Santos, *S. hatschbachii* E. P. Santos, *S. heerii* Regel, *S. henryi* A. Gray, *S. herrerae* Epling, *S. hidalgensis* Miranda, *S. hilarii* Benth., *S. hirta* Kunth, *S. hirtella* Vahl, *S. holwayi* S. F. Blake

S. integrifolia Ruiz & Pav., *S. involucrata* Cav., *S. iodantha* Fernald, *S. iodophylla* Epling, *S. itaguassuensis* Brade & Barb. Per., *S. iuliana* Epling

S. jorgehintoniana Ramamoorthy ex B. L. Turner

S. karwinskii Benth.

S. lachnaioclada Briq., *S. lachnostoma* Epling, *S. lanicaulis* Epling & Játiva, *S. lasiantha* Benth., *S. lavendula* Alain, *S. leucantha* Cav., *S. leucocephala* Kunth, *S. libanensis* Rusby, *S. lineata* Benth., *S. littae* Vis., *S. lobbii* Epling, *S. longibracteolata* E. P. Santos, *S. longistyla* Benth.

S. macrocalyx Gardner, *S. macrophylla* Benth., *S. madrensis* Seem., *S. marci* Epling, *S. mattogrossensis* Pilg., *S. medusa* Epling & Játiva, *S. melaleuca* Epling, *S. melissiflora* Benth., *S. mentiens* Pohl, *S. microphylla* Kunth, *S. miniata* Fernald

S. neovidensis Benth., *S. nervata* M. Martens & Galeotti, *S. nigrescens* Alain (nom. illeg.).

S. oaxacana Fernald, *S. ombrophila* Dusén, *S. oppositiflora* Ruiz & Pav., *S. orbignaei* Benth., *S. orthostachys* Epling, *S. oxyphora* Briq.

S. palealis Epling, *S. paramicola* Fern. Alonso, *S. paryskii* Skean & Judd, *S. patens* Cav., *S. pauciserrata* Benth., *S. pavonii* Benth., *S. peninsularis* Brandegee, *S. pentstemonoides* Kunth & C. D. Bouché, *S. persicifolia* A. St.-Hil., *S. phaenostemma* Donn. Sm., *S. pichinchensis* Benth., *S. plumosa* Ruiz & Pav., *S. pringlei* B. L. Rob. & Greenm., *S. psilantha* Epling, *S. pubescens* Benth., *S. pulchella* DC.

S. quitensis Benth.

S. raveniana Ramamoorthy, *S. regla* Cav., *S. regnelliana* Briq., *S. rhodostephana* Epling, *S. rivularis* Gardner ex H. B. Fielding, *S. roemeriana* Scheele, *S. rosei* Fernald, *S. rubescens* Kunth, *S. rubrifaux* Epling, *S. rubriflora* Epling, *S. rufula* Kunth, *S. rusbyi* Britton ex Rusby

S. sagittata Ruiz & Pav., *S. salicifolia* Pohl, *S. scabrata* Britton & P. Wilson, *S. scabrida* Pohl, *S. scandens* Epling, *S. sciaphila* (J. R. I. Wood & Harley) Fern. Alonso, *S. secunda* Benth., *S. sellowiana* Benth., *S. sessei* Benth., *S. sigchosica* Fern. Alonso, *S. spathacea* Greene, *S. speciosa* C. Presl ex Benth., *S. speirematoides* C. Wright, *S. splendens* Sellow ex Roem. & Schult., *S. sprucei* Briq., *S. squalens* Kunth, *S. stolonifera* Benth., *S. striata* Benth., *S. subhastata* Epling, *S. subrotunda* A. St.-Hil. ex Benth., *S. subrubens* Epling, *S. summa* A. Nelson

S. tenuiflora Epling, *S. thormannii* Urb., *S. tolimensis* Kunth, *S. tomentella* Pohl, *S. tortuosa* Kunth (including *S. corazonica* Gilli), *S. townsendii* Fernald, *S. trachyphylla* Epling, *S. tubifera* Cav., *S. tubiflora* Sm., *S. tubulosa* Epling, *S. tuerckheimii* Urb.

S. uncinata Urb., *S. unguella* Epling, *S. univerticillata* Ramamoorthy ex Klitg.

S. venulosa Epling, *S. verapazana* B. L. Turner, *S. vestita* Benth.

S. wagneriana Pol., *S. weberbaueri* Epling

S. xanthotricha Harley ex E. P. Santos, *S. xeropapillosa* Fern. Alonso

MELITTOPHILOUS (351 SPP.)

S. acerifolia B. L. Turner, *S. aequidistans* Fernald, *S. agnes* Epling, *S. alamosana* Rose, *S. alariformis* L. O. Williams, *S. alba* J. R. I. Wood, *S. albiflora* M. Martens & Galeotti, *S. albocaerulea* Linden, *S. aliciae* E. P. Santos, *S. alvajaca* Oerst., *S. amarissima* Ortega, *S. amissa* Epling, *S. amplifrons* Briq., *S. anastomosans* Ramamoorthy, *S. anguicoma* Epling, *S. angulata* Benth., *S. apiana* Jeps., *S. aratocensis* (J. R. I. Wood & Harley) Fern. Alonso, *S. areolata* Epling, *S. aridicola* Briq., *S. arizonica* A. Gray, *S. arthrocoma* Fernald, *S. assurgens* Kunth, *S. austromelissodora* Epling & Játiva, *S. axillaris* Moç. & Sessé ex Benth., *S. axilliflora* Epling, *S. azurea* Michx. ex Lam.

S. ballotiflora Benth., *S. betonica* Schult., *S. biserrata* M. Martens & Galeotti, *S. boegei* Ramamoorthy, *S. bogotensis* Benth., *S. borjensis* E. P. Santos, *S. brachyodonta* Briq., *S. brachyphylla* Urb., *S. brandegeei* Munz, *S. breviflora* Moç. & Sessé ex Benth., *S. brevipes* Benth.

S. caaguazuensis Briq., *S. cabonii* Urb., *S. calaminthifolia* Vahl, *S. calcicola* Harley, *S. californica* Brandegee, *S. calolophos* Epling, *S. campicola* Briq., *S. candicans* M. Martens & Galeotti, *S. capillosa* Epling, *S. cardenasii* J. R. I. Wood, *S. cardiophylla* Benth., *S. carduacea* Benth., *S. caudata* Epling, *S. caymanensis* Millsp. & Uline ex Millsp., *S. cedrosensis* Greene, *S. cerradicola* E. P. Santos, *S. chalarothyrsa* Fernald, *S. chamaedryoides* Cav., *S. chapalensis* Briq., *S. chazaroana* B. L. Turner, *S. chicamochae* J. R. I. Wood & Harley, *S. chionophylla* Fernald, *S. clarendonensis* Britton, *S. clinopodioides* Kunth, *S. coahuilensis* Fernald, *S. codazziana* Fern. Alonso, *S. cognata* Urb. & Ekman, *S. collinsii* Donn. Sm., *S. colonica* Standl. & L. O. Williams ex Klitg., *S. columbariae* Benth., *S. comayaguana* Standl., *S. compsostachys* Epling, *S. congestifolia* Epling, *S. connivens* Epling, *S. consimilis* Epling, *S. consobrina* Epling, *S. cordata* Benth., *S. corrugata* Vahl, *S. costaricensis* Oerst., *S. coulteri* Fernald, *S. crucis* Epling, *S. cruckshanksii* Benth., *S. cryptodonta* Fernald, *S. cuatrecasana* Epling, *S. curta* Epling, *S. curticalyx* Epling, *S. cuspidata* Ruiz & Pav., *S. cyanantha* Epling, *S. cyanicalyx* Epling, *S. cyanotropha* Epling

S. dasycalyx Fernald, *S. decumbens* Alain, *S. decurrens* Epling, *S. densiflora* Benth., *S. dorrii* (Kellogg) Abrams, *S. drymocharis* Epling, *S. dryophila* Epling, *S. durantiflora* Epling, *S. durifolia* Epling, *S. duripes* Epling & Mathias

S. emaciata Epling, *S. engelmannii* A. Gray, *S. eplingiana* Alziar, *S. eriocalyx* Bertero ex Roem. & Schult., *S. exilis* Epling, *S. expansa* Epling

S. fallax Fernald, *S. farinacea* Benth., *S. fernaldii* Standl., *S. festiva* Epling, *S. filifolia* Ramamoorthy, *S. filipes* Benth., *S. firma* Fernald, *S. flaccida* Fernald, *S. flaccidifolia* Fernald, *S. flocculosa* Benth., *S. fluviatilis* Fernald, *S. forreri* Greene, *S. fracta* L. O. Williams, *S. fruticulosa* Benth., *S. fusca* Epling, *S. fuscomanicata* Fern. Alonso

S. galloana B. L. Turner, *S. glabra* M. Martens & Galeotti, *S. glechomifolia* Kunth, *S. goldmanii* Fernald, *S. gracilipes* Epling, *S. grisea* Epling & Mathias, *S. griseifolia* Epling, *S. guadalajarensis* Briq., *S. gypsophila* B. L. Turner

S. haitiensis Urb., *S. hamulus* Epling, *S. helianthemifolia* Benth., *S. herbacea* Benth., *S. hermesiana* Fern. Alonso, *S. heterofolia* Epling & Mathias, *S. heterotricha* Fernald, *S. hintonii* Epling, *S. hirsuta* Jacq., *S. hispanica* L., *S. hotteana* Urb. & Ekman, *S. humboldtiana* F. Dietr.

S. igualensis Fernald, *S. incumbens* Urb. & Ekman, *S. incurvata* Ruiz & Pav., *S. indigocephala* Ramamoorthy, *S. infuscata* Epling, *S. innoxia* Epling & Mathias, *S. inornata* Epling, *S. intonsa* Epling

S. jacalana B. L. Turner, *S. jacobi* Epling, *S. jaimehintoniana* Ramamoorthy ex B. L. Turner, *S. jamaicensis* Fawc., *S. jaramilloi* Fern. Alonso

S. keerlii Benth.

S. lachnostachys Benth., *S. laevis* Benth., *S. lamiifolia* Jacq., *S. langlassei* Fernald, *S. languidula* Epling, *S. lanicalyx* Epling, *S. lasiocephala* Hook. & Arn., *S. lavanduloides* Kunth, *S. laxispicata* Epling, *S. leninae* Epling, *S. lenta* Fernald, *S. leptostachys* Benth., *S. leucochlamys* Epling, *S. leucophylla* Greene, *S. longispicata* M. Martens & Galeotti, *S. lophanthoides* Fernald, *S. loxensis* Benth., *S. lozanii* Fernald, *S. lycioides* A. Gray, *S. lyrata* L.

S. malvifolia Epling & Játiva, *S. manantlanensis* Ramamoorthy, *S. manaurica* Fern. Alonso, *S. mazatlanensis* Fernald, *S. melissodora* Lag., *S. mellifera* Greene, *S. mexiae* Epling, *S. micrantha* Vahl, *S. minarum* Briq., *S. misella* Kunth, *S. mocinoi* Benth., *S. monantha* Brandegee ex Epling, *S. monclovensis* Fernald, *S. moniliformis* Fernald, *S. montecristina* Urb. & Ekman, *S. mornicola* Urb. & Ekman, *S. mucidiflora* Fernald, *S. munzii* Epling, *S. muscarioides* Fernald

S. nana Kunth, *S. nepetoides* Kunth, *S. nervosa* Benth., *S. nitida* (M. Martens & Galeotti) Benth., *S. novoleontis* B. L. Turner

S. oblongifolia M. Martens & Galeotti, *S. obtorta* Epling, *S. occidentalis* Sw., *S. occidua* Epling, *S. occultiflora* Epling, *S. ocimifolia* Epling, *S. oligantha* Dusén, *S. ophiocephala* J. R. I. Wood, *S. oreopola* Fernald, *S. ovalifolia* A. St.-Hil. ex Benth.

S. pachypoda Briq., *S. palifolia* Kunth, *S. pallida* Benth., *S. palmeri* A. Gray, *S. pamplonitana* Fern. Alonso, *S. pannosa* Fernald, *S. paposana* Phil., *S. paraguariensis* Briq., *S. parciflora* Urb., *S. parryi* A. Gray, *S. paulwalleri* B. L. Turner, *S. paupercula* Epling, *S. penduliflora* Epling, *S. pennellii* Epling, *S. perblanda* Epling, *S. peregrina* Epling, *S. pericona* B. L. Turner, *S. perlucida* Epling, *S. perplicata* Epling, *S. personata* Epling, *S. pineticola* Epling, *S. pinguifolia* (Fernald) Woot. & Standl., *S. pinosiana* Gladkova, *S. platycheila* A. Gray, *S. platyphylla* Briq., *S. plurispicata* Epling, *S. podadena* Briq., *S. polystachya* Cav., *S. potus* Epling, *S. praeterita* Epling, *S. prasiifolia* Benth., *S. primuliformis* Epling, *S. procurrens* Benth., *S. propinqua* Benth., *S. prostrata* Hook. f., *S. protracta* Benth., *S. pruinosa* Fernald, *S. prunelloides* Kunth, *S. pseudoincisa* Epling, *S. pseudomisella* Moran & G. A. Levin, *S. pseudopallida* Epling, *S. pseudoprivoides* Epling, *S. pseudoserotina* Epling, *S. pteroura* Briq., *S. purpusii* Brandegee, *S. pusilla* Fernald

S. quercetorum Epling

S. ramamoorthyana Espejo, *S. ramosa* Brandegee, *S. raymondii* J. R. I. Wood, *S. reflexa* Hornem., *S. reitzii* Epling, *S. remissa* Epling, *S. remota* Benth., *S. reptans* Jacq., *S. rhinosina* Griseb., *S. rhombifolia* Ruiz & Pav., *S. rhyacophila* Epling, *S. richardsonii* B. L. Turner, *S. roscida* Fernald, *S. rosmarinoides* A. St.-Hil. ex Benth., *S. rostellata* Epling, *S. rubropunctata* B. L. Rob. & Fernald, *S. rupicola* Fernald, *S. rypara* Briq., *S. rzedowskii* Ramamoorthy

S. saccifera Urb. & Ekman, *S. sacculus* Epling, *S. sanctae-luciae* Seem., *S. sapinea* Epling, *S. sarmentosa* Epling, *S. scaposa* Epling, *S. scoparia* Epling, *S. scytinophylla* Briq., *S. seemannii* Fernald, *S. selguapensis* Ant. Molina, *S. selleana* Urb., *S. serotina* L., *S. serpyllifolia* Fernald, *S. serranoae* J. R. I. Wood, *S. setosa* Fernald, *S. setulosa* Fernald, *S. shannonii* Donn. Sm., *S. similis* Brandegee, *S. sinaloensis* Fernald, *S. sochensis* (J. R. I. Wood & Harley) Fern. Alonso, *S. sonomensis* Greene, *S. sophrona* Briq., *S. sordida* Benth., *S. sparsiflora* Epling, *S. sphacelifolia* Epling, *S. sphacelioides* Benth., *S. stachydifolia* Benth., *S. stachyoides* Kunth, *S. styphelus* Epling, *S. subaequalis* Epling, *S. subglabra* (Urb.) Urb., *S. subincisa* Benth., *S. subobscura* Epling, *S. subpatens* Epling, *S. subscandens* Epling & Játiva, *S. sucrensis* J. R. I. Wood, *S. synodonta* Epling

S. tafallae Benth., *S. tehuacana* Fernald, *S. tenella* Sw., *S. tenorioi* Ramamoorthy ex B. L. Turner, *S. tepicensis* Fernald, *S. teresae* Fernald, *S. texana* (Scheele) Torr., *S. textitlana* B. L. Turner, *S. thomasiana* Urb., *S. thymoides* Benth., *S. thyrsiflora* Benth., *S. tiliifolia* Vahl, *S. tonalensis* Brandegee, *S. tortuensis* Urb., *S. trichopes* Epling, *S. tricuspidata* M. Martens & Galeotti, *S. trifilis* Epling, *S. turneri* Ramamoorthy, *S. tuxtlensis* Ramamoorthy

S. uliginosa Benth., *S. umbraticola* Epling, *S. unicostata* Fernald, *S. uribei* J. R. I. Wood & Harley, *S. urica* Epling, *S. urolepis* Fernald, *S. urticifolia* L., *S. uruapana* Fernald

S. vargasii Epling, *S. verecunda* Epling, *S. veronicifolia* A. Gray ex S. Watson, *S. villosa* Fernald, *S. viscida* A. St.-Hil. ex Benth., *S. vitifolia* Benth.

S. whitefoordiae Klitg.

S. xalapensis Benth., *S. xanthophylla* Epling & Játiva

S. zacualpanensis Briq., *S. zacuapanensis* Brandegee, *S. zaragozana* B. L. Turner

Psychophilous (1 sp.)

S. whitehousei Alziar

Intermediate (Ornithophilous, Melittophilous, Psychophilous)

ornithophilous, melittophilous, and/or intermediate (36 spp.)

S. angustiarum Epling, *S. arenaria* A. St.-Hil. ex Benth., *S. aspera* M. Martens & Galeotti, *S. atrocalyx* Epling, *S. atropaenulata* Epling, *S. bullulata* Benth., *S. camporum* Epling, *S. carbonoi* Fern. Alonso, *S. chiapensis* Fernald, *S. costata* Epling, *S. dichlamys* Epling, *S. ecuadorensis* Briq., *S.*

eizi-matudae Ramamoorthy, *S. erythrostoma* Epling, *S. ionocalyx* Epling, *S. kellermanii* Donn. Sm., *S. mendax* Epling, *S. modica* Epling, *S. muelleri* Epling, *S. nubigena* J. R. I. Wood & Harley, *S. nubilorum* Epling & Játiva, *S. obumbrata* Epling, *S. opertiflora* Epling, *S. oresbia* Fernald, *S. pansamalensis* Donn. Sm., *S. perlonga* Fernald, *S. pexa* Epling, *S. praestans* Epling, *S. pseudorosmarinus* Epling, *S. punctata* Ruiz & Pav., *S. purpurea* Cav., *S. revoluta* Ruiz & Pav., *S. sharpii* Epling & Mathias, *S. silvarum* Epling, *S. umbratilis* Fernald, *S. viscidifolia* Epling

ORNITHOPHILOUS TO ORNITHOPHILOUS, MELITTOPHILOUS, AND/OR INTERMEDIATE TO MELITTOPHILOUS (1 SP.)

S. carnea Kunth

ORNITHOPHILOUS TO ORNITHOPHILOUS, MELITTOPHILOUS, OR INTERMEDIATE (6 SPP.)

S. amethystina Sm., *S. concolor* Lamb. ex Benth., *S. mexicana* L., *S. ochrantha* Epling, *S. recurva* Benth., *S. semiatrata* Zucc.

MELITTOPHILOUS AND/OR INTERMEDIATE (7 SPP.)

S. ampelophylla Epling, *S. discolor* Kunth, *S. macellaria* Epling, *S. macrostachya* Kunth, *S. retinervia* Briq., *S. scutellarioides* Kunth, *S. yukoyukparum* Fern. Alonso

ORNITHOPHILOUS, PSYCHOPHILOUS, AND/OR INTERMEDIATE (4 SPP.)

S. chionopeplica Epling, *S. clevelandii* (A. Gray) Greene, *S. mohavensis* Greene, *S. pachyphylla* Epling ex Munz

MELITTOPHILOUS, PSYCHOPHILOUS, ORNITHOPHILOUS, AND/OR INTERMEDIATE (2 SPP.)

S. eremostachya Jeps., *S. vaseyi* (Porter) Parish

MELITTOPHILOUS, PSYCHOPHILOUS, AND/OR INTERMEDIATE (2 SPP.)

S. funerea M. E. Jones, *S. greatae* Brandegee

NOT ASSIGNABLE (LACKING DATA)

S. alata Epling, *S. arborescens* Urb. & Ekman, *S. brachyloba* Urb., *S. buchii* Urb., *S. microdictya* Urb. & Ekman, *S. psilostachya* Epling, *S. strobilanthoides* C. Wright ex Griseb., *S. trichostephana* Epling

APPENDIX 3. Taxonomic note.

Salvia tortuosa Kunth, Nov. Gen. Sp. [H.B.K.] 2: 292. 1818. TYPE: Colombia. *Humboldt & Bonpland s.n.* (holotype, P!).
Salvia corazonica Gilli, Feddes Repert. 94: 316. 1983, syn. nov. TYPE: Ecuador. El Corazon, 1630 m, 30 June 1975, *Gilli 284* (holotype, W!).

Salvia ampelophylla Epling, *S. aratocensis* (J. R. I. Wood & Harley) Fern. Alonso, and *S. sochensis* (J. R. I. Wood & Harley) Fern. Alonso might be also regarded as subspecies (*S. amethystina* J. E. Smith subsp. *ampelophylla* (Epling) J. R. I. Wood & Harley, *S. bogotensis* Benth. subsp. *aratocensis* J. R. I. Wood & Harley, and *S. bogotensis* Benth. subsp. *sochensis* J. R. I. Wood & Harley) (Wood & Harley, 1989; J. Wood, pers. comm.).